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BULLETIN 935 1985

A GUIDE TO THE TICKS OF MISSISSIPPI

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A GUIDE TO THE TICKS OF MISSISSIPPI

Members of the superfamily Ixodoidea, or ticks, are acarines that feed obligately on the blood of mammals, reptiles and birds. They have a leathery, undifferentiated body with no distinct head, but the mouth parts together with the basis capituli form a headlike structure. Mature ticks and nymphs have four pair of legs, and the larvae have three pair.

The two major families of ticks recognized in North America–(Figure 1) are Ixodidae (hard ticks) and Argasidae (soft ticks). Hard ticks are scutate with obvious sexual dimorphism and the blood-fed females are capable of enormous expansion. Their mouthparts are anterior and visible from dorsal view. Soft ticks are nonscutate without obvious sexual dimorphism and are mainly adapted for feeding rapidly and leaving the host promptly. Their mouthparts are generally subterminal and not visible from dorsal view.

Ticks are of significant medical and veterinary importance, and knowledge of species present in a given area is important to physicians, veterinarians and livestock personnel. Several projects conducted by wildlife researchers have cited tick records from Mississippi (Andrews et al., 1980; Demarais, 1979; Handrick, 1981; Jacobson and Hurst, 1979; Prestwood, 1968 and Smith, 1977). Other medical or veterinary projects have reported tick records from the state (Archer, 1946; Carpenter et al., 1946; Nause and Norment, 1984; Norment et al., 1985; Philip and White, 1955; Rhodes and Norment, 1979). There is a paucity of information on the distributuion and abundance of ticks in Mississippi.

Hard ticks have a four-stage life history. Some ticks complete their development on only one or two hosts, but most Mississippi ticks have a three-host life cycle. A fully fed female tick drops from the host animal to the ground and lays from 5,000 to 18,000 eggs. The eggs hatch in about 35 days into a six-legged seed-tick stage, which feeds predominantly on small animals. The fully fed seed ticks drop to the ground and transform into eight-legged nymphs. These nymphs seek an animal host and likewise feed and drop to the ground. They then transform into the adult stage, thus completing the life cycle.

The biology of soft ticks differs from that of hard ticks. Adult soft ticks feed repeatedly whereas hard ticks feed once and lay eggs. Argasid females may feed

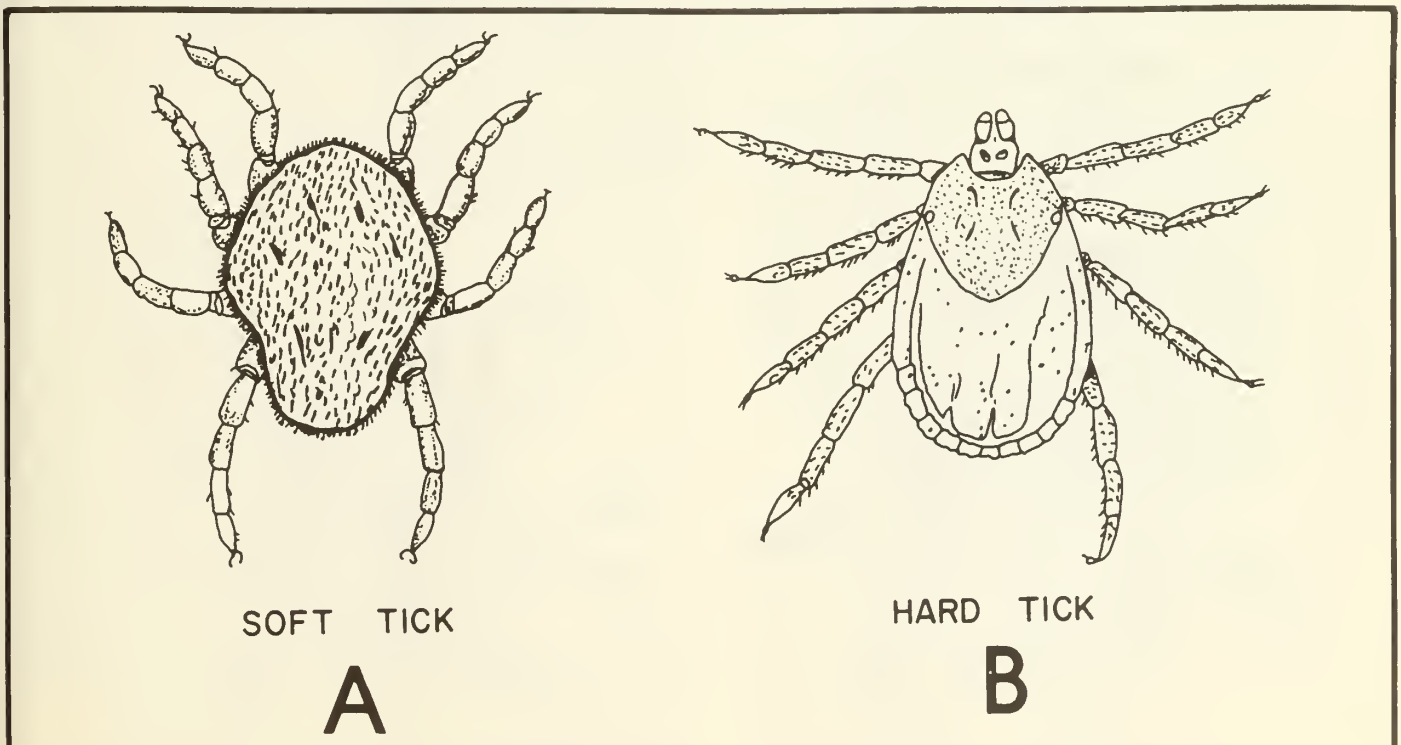


Figure 1. Dorsal view of argasid and ixodid ticks.

Female Black Legged Tick

Male Black Legged Tick

Female American Dog Tick

Male American Dog Tick

Female Gulf Coast Tick

Male Gulf Coast Tick

Female Lone Star Tick

Male Lone Star Tick

Female Rabbit Tick

Male Rabbit Tick

Female Brown Dog Tick

Male Brown Dog Tick

and lay eggs several times but lay fewer eggs than do hard ticks. Also, soft-tick species may undergo several nymphal molts before reaching the adult stage.

This bulletin summarizes the knowledge gained thus far on the ticks of Mississippi. The collection records and literature show 17 species as occurring or having occurred. These records come from citations in the literature, the Rocky Mountain Laboratory records, specimens in the Mississippi Entomological Museum and specimens collected by the authors throughout northern Mississippi in 1981-84. Voucher specimens representing 13 of the 17 species discussed are deposited in the Mississippi Entomological Museum or in the National Museum of Natural History (original Rocky Mountain Laboratory specimens).

Fifteen of the species presented are Ixodidae (hard ticks), and two are Argasidae (soft ticks). The records for *Argas persicus* (Oken), the Fowl tick; *Amblyomma cajennense* (Fabricus), the Cayenne tick and *Ixodes kingi* Bishopp, the Rotund tick are questionable in that we don"t have specimens available for verification. Also, *Boophilus annulatus* (Say), the Cattle tick, was eradicated during the tick eradication program of the early 1900's.

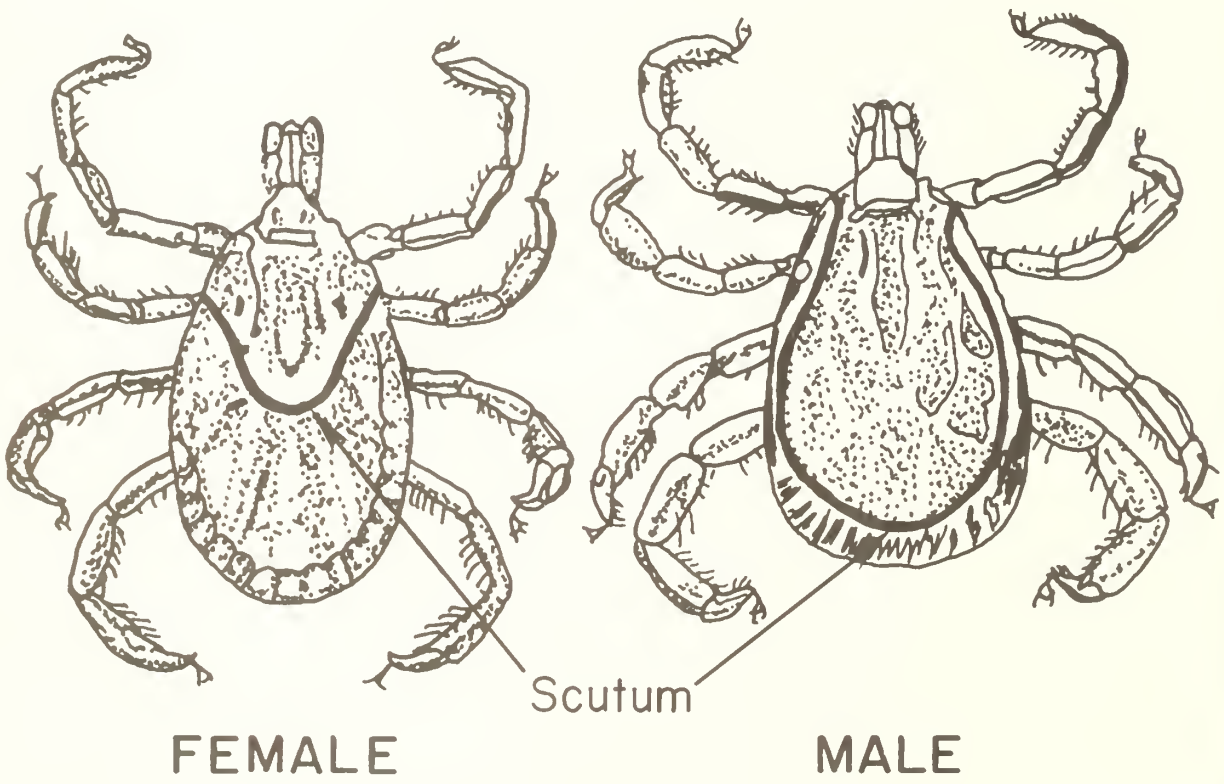


Figure 2. Dorsal view of Ixodid ticks. A. Female B. Male

List Of Tick Species Occurring Or Having Occurred In Mississippi

Family Argasidae
Otobius megnini (Duges), Spinose Ear tick.
**Argas persicus* (Oken), Fowl tick.
Family Ixodidae
Boophilus annulatus (Say), Cattle tick, eradicated
Amblyomma americanum (Linnaeus), Lone Star tick
**Ambloymma cajennense* (Fabricius), Cayenne tick
Amblyomma maculatum (Koch), Gulf Coast tick
Ambloyomma tuberculatum Marx, Gopher Tortoise tick
Dermacentor albipictus Packard, Winter tick
Dermacentor variabilis (Say), American Dog tick
Haemaphysalis leporispalustris (Packard), Rabbit tick
Ixodes brunneus Koch, No Common Name
Ixodes cookei Packard, No Common Name
Ixodes dentatus Marx, No Common Name
**Ixodes kingi* Bishopp, Rotund tick
Ixodes scapularis Say, Black Legged tick
Ixodes texanus Banks, Raccoon tick
Rhipicephalus sanguineus (Latreille), Brown Dog tick

**Occurrence in Mississippi questionable.*

Identification Guide To Ticks [1, 2] Affecting Man In Mississippi, By Season Of The Year

Winter (Dec - Jan)
If adult ticks probably *Ixodes scapularis*

Early Spring (Feb - Mar)
If adult ticks probably *Ixodes scapularis* or *Amblyomma americanum*
If nymphal ticks probably *Amblyomma americanum*

Late Spring (Apr - May)
If adult ticks probably *Amblyomma americanum* or *Amblyomma maculatum*
If adult ticks possibly *Dermacentor variabilis*
If nymphal ticks probably *Amblyomma americanum*

Early Summer (Jun - Jul)
If adult ticks and bite man could be either *Amblyomma americanum, Amblyomma maculatum* or *Dermacentor variabilis*
If adult ticks, in or around homes with dogs and don't bite man then *Rhipicephalus sanguineus*
If nymphal ticks probably *Amblyomma americanum*

Late Summer (Aug - Sep)
If adult ticks and bite man probably *Dermacentor variabilis*
If adult ticks in and around homes and don't bite man then *Rhipicephalus sanguineus.*
If larval or nymphal ticks probably *Amblyomma americanum.*

Fall (Oct - Nov)
If adults possibly *Dermacentor variabilis* or *Ixodes scapularis*
If larval ticks probably *Amblyomma americanum.*

[1] *Including only the five most common Mississippi ticks.*
[2] *Intended as a guide only and not for definitive indentification*

Key to Families and Genera of Adult Ticks

Scutum present, Capitulum terminal and conspicuous from above (Fig. 1B) . . . . . Family Ixodidae
Scutum absent, Capitulum on underside of body and inconspicuous [Fig. 1A] . . . . . Family Argasidae

Family Argasidae
Key to Genera of Argasidae
(Mississippi)

Margin of body thick, rounded without definite sutural line; integument spinose: body plump . . . . . Genus *Otobius*
Margin of body with definite sutural line; integument not as above: body distinctly flattened dorso-ventrally . . . . . Genus *Argas*

Family Ixodidae
Key to Genera of Ixodidae
(Mississippi)

1. Anal groove on ventor curves about the anus in front; festoons and eyes absent; scutum inornate (Fig. 4E) . . . . . Genus *Ixodes*
1.' Anal groove on ventor curves about the anus behind or is absent; festoons present or absent; eyes present or absent; scutum ornate or inornate 2
2. Eyes absent; second palpal segment projects laterally beyond basis capituli (Fig. 3E) . . . . . Genus *Haemaphysalis*
2.' Eyes present; second palpal segment does not project laterally beyond basis capituli 3
3. Basis capitulum laterally produced; scutum usually inornate (Figs. 4A,4C) 4
3.' Basis capitulum not laterally produced; scutum usually ornate 5
4. Spiracular plate (Stigma) oval; festoons absent (Figs. 3A, 4A) . . . . . Genus *Boophilus*
4.' Spiracular plate (Stigma) comma-shaped; festoons present (Figs. 4C,3F) . . . . . Genus *Rhipicephalus*
5. Second segment of palpi about as long as wide; Coxa I deeply bifed (Figs. 3C, 4B) . . . . . Genus *Dermacentor*
5.' Second segment of palpi twice as long as wide; Coxa I not bifed (Figs. 3D, 4D) . . . . . Genus *Amblyommoa*

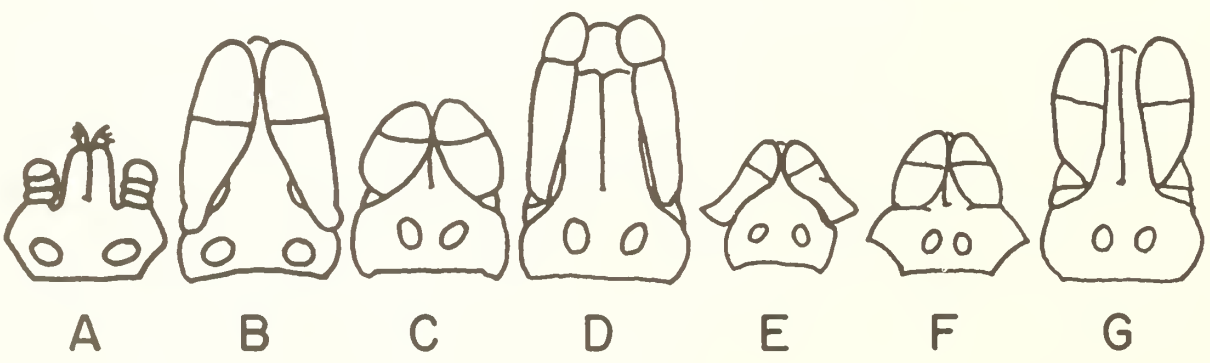
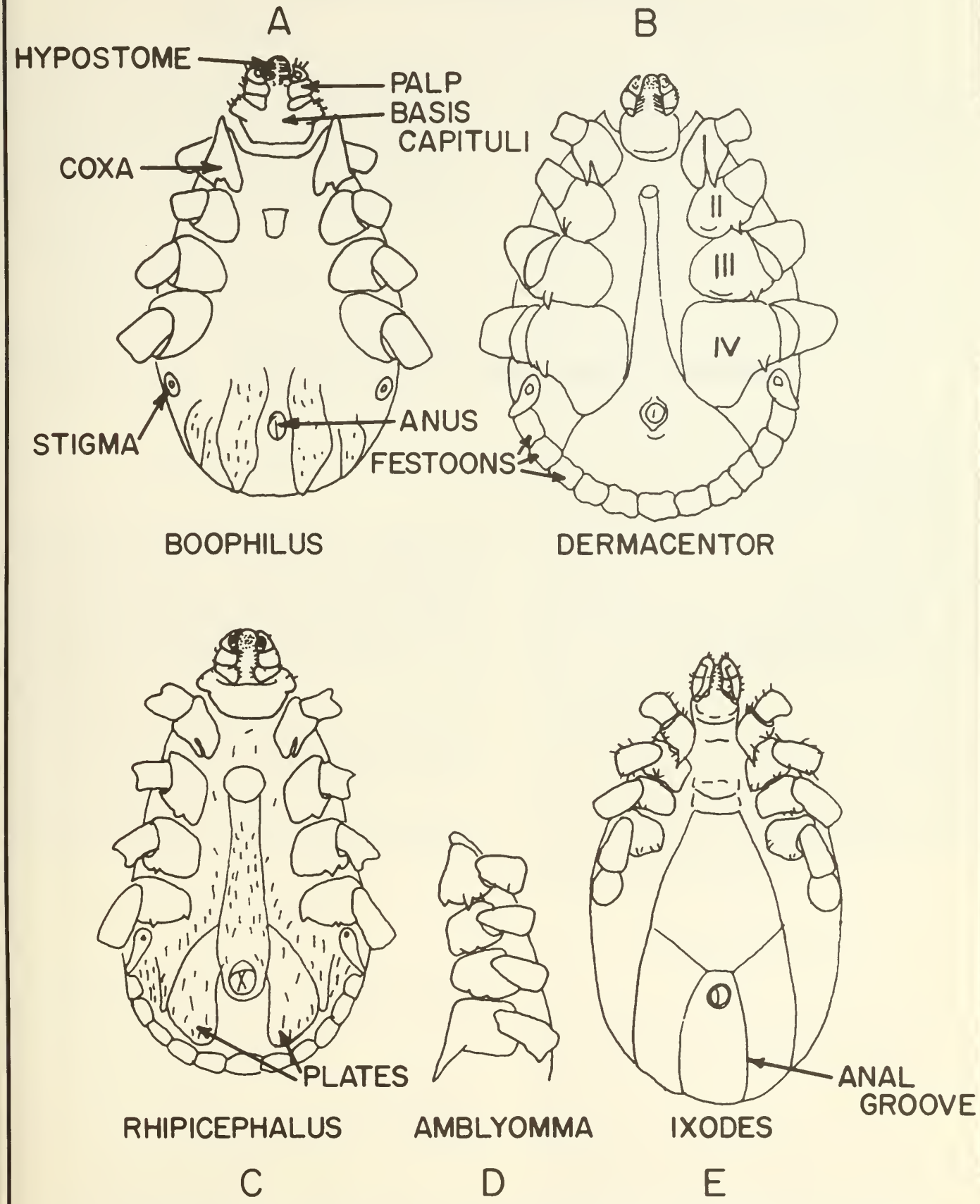


Figure 3. Charactgeristic capitula of several genera of ixodid ticks (dorsal view). A. *Boophilus.* **B.** *Ixodes.* **C.** *Dermacentor.* **D.** *Amblyomma.* **E.** *Haemaphysalis.* **F.** *Rhipicephalus.* **G.** *Hyalomma* **(Redrawn with permission from Harwood and James 1979 Entomology in Human and Animal Health, Macmillan Co.).**



Firgure 4. Ventral aspects of male ixodid ticks (Redrawn with permission from Georgi, 1974; Parasitology for Veterinarians, W. B. Saunders Co.).

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Species Annotations

Argas Persicus
(Fowl Tick)

The Fowl tick is one of the most cosmopolitan poultry parasites. This species is strikingly active at night, traveling some distance to its hosts and then back to hiding places where it stays during the day. It is not known to transmit disease to humans.

Mississippi distribution: The only collection record we have is from Oktibbeha County (Ward, 1932) and its validity is questionable.

Mississippi seasonal occurrence: Unknown

Mississippi hosts: No host given.

Diagnostic characteristics of the species: Since *Argas persicus* in the U.S. actually represents a complex of species, no diagnostic characters are included here.

Voucher specimens: None available.

Otobius megnini
(Ear tick)

The Ear tick is widely distributed throughout the United States and is an important parasite of horses, mules, sheep, cats, dogs and especially cattle. Nymphs occasionally may be found attached in the ears of people (Harwood and James, 1979).

Mississippi distribution: Warren County.

Mississippi seasonal occurrence: November and December.

Mississippi hosts: Cattle

Diagnostic characteristics of the species: Nymphs are the stage most often encountered and have a profusely spinose integument. Dentition of hypostome 4/4, Spiracles conical.

Voucher specimens: Mississippi Entomological Museum, Mississippi State University (MEM #8-3).

Boophilus annulatus
(Cattle tick)

Boophilus annulatus was widely distributed in the southern United States in the early 1900's. It is the vector of Texas Cattle fever which is a very destructive epizootic among cattle.

We have only one collection record from Mississippi dated December 31, 1914, from Franklin County. The most important host of this tick is cattle, but early authors also listed deer, horse, mule, sheep, goat and bison.

Voucher specimens: Rocky Mountain Laboratories accession number 060956.

Amblyomma americanum
(Lone star tick)

The Lone Star tick is one of the most annoying and economically important species in the United States. It is non-specific, feeding on a wide variety of birds and mammals, and often occurs in extremely large numbers. It is most abundant in the south central United States from Texas to the Atlantic coast and has been reported as a vector of several human diseases such as Rocky Mountain spotted fever, Q fever,Lyme disease, tularemia, and 'Lone Star virus' (Parker et al., 1943; Parker and Kohls, 1943; Schulze et al., 1984; Hopla and Downs, 1953; Kokernot et al., 1969). However, recent evidence suggests that *A. americanum* is not a vector of spotted fever.

Mississippi distribution: Adams, Amite, Bolivar, Chickasaw, Choctaw, Claiborne, Clay, Forrest, George, Harrison, Hinds, Jackson, Jeff Davis, Jefferson, Lafayette, Marshall, Monroe, Noxubee, Oktibbeha, Perry, Scott, Stone, Tishomingo, Warren, Wayne, Webster, Wilkinson, Winston and Yazoo counties.

Mississippi seasonal occurrence: February to November.

Mississippi hosts: cat, cottontail rabbit, cow, dog, eastern wood rat, gray squirrel, hispid cotton rat, house mouse, marsh rice rat, norway rat, opossum, raccoon, swamp rabbit, white-footed mouse, white-tailed deer and wild turkey.

Diagnostic characteristics of the species: Males with internal spur of Coxa I moderately long and scutum with inverted horseshoe markings at posterior edge; females with external spur of Coxa I distinctly longer than internal and scutum with distinct white spot.

Voucher specimens: Mississippi Entomological Museum, MSU (MEM #8-4).

Amblyomma cajennense
(Cayenne tick)

The Cayenne tick occurs generally only in the extreme southern United States. All stages of this species attack man and many animals. It is not reported to transmit disease to humans in the United States.

Mississippi distribution: Bolivar County

Mississippi seasonal occurrence: Unknown

Mississippi hosts: Wild turkey (Prestwood, 1968).

Diagnostic characteristics of the species: Males with internal spur of Coxa I moderately long and scutum

with web-like design radiating from the center; Females with external spur of Coxa I distinctly longer than internal; scutum with extensive ornamentation and festoons with tubercles at posterior edge.

Voucher specimens: None available.

Amblyomma maculatum
(Gulf Coast tick)

The Gulf Coast tick is of considerable economic importance especially in relation to livestock. Adults of this species attach inside the ears of animals and produce inflammation and swelling. They readily bite people and may transmit Q fever (Philip and White, 1955). This species is most abundant along the Gulf and South Atlantic coasts. Bishopp and Hixson (1936) reported that this tick is seldom found farther than 100 miles inland; however, its distribution probably extends much farther northward (Goddard and Norment, 1983a).

Mississippi distribution: Forrest, George, Harrison, Hinds, Jackson, Jasper, Lafayette, Marion, Noxubee, Oktibbeha and Pearl River counties.

Mississippi seasonal occurrence: March through October.

Mississippi hosts: White-tail deer and cattle.

Diagnostic characteristics of the species: Coxa I with internal spur very short or insignificant; males and females with abundant ornamentation in an extensive pattern.

Voucher specimens: Mississippi Entomological Museum, MSU (MEM #8-2).

Amblyomma tuberculatum
(Gopher Tortoise tick)

The Gopher Tortoise tick is a large species that is host specific to the Gopher Tortoise, *Gopherus polyphemus*. It is of minor medical and economic importance and ordinarily does not bite people. This species mainly occurs on the sandy coastal areas of Alabama, Florida, Georgia, Mississippi and South Carolina.

Mississippi distribution: George, Pearl River and Stone counties.

Mississippi seasonal occurrence: June to September.

Mississippi hosts: Gopher Tortoise.

Diagnostic characteristics of the species: Coxa IV with both spurs very small and equal in length.

Voucher specimens: Rocky Mountain laboratories accession number 056909.

Dermacentor albipictus
(Winter tick)

The Winter tick (the southern form is sometimes called *D. nigrolineatus*), is a significant pest of horses, cattle and wild hoofed mammals. This species is active only in the late fall, winter and early spring. It mainly occurs in the northern United States; however, it is irregularly distributed in several southern states.

Mississippi distribution: Adams, Attala, Chickasaw, Choctaw, Claiborne, Clark, Harrison, Hinds, Jasper, Jefferson, Noxubee, Perry, Smith, Warren and Washington counties.

Mississippi seasonal occurrence: October to April.

Mississippi hosts: Deer, horses and mules.

Diagnostic characteristics of the species: Spurs on Coxa I not divergent and spiracular plate without obvious pointed projection. Ornate (*D. albipictus*), or inornate (*D. nigrolineatus*).

Voucher specimens: Rocky Mountain laboratories accession number 059856.

Dermacentor variabilis
(American Dog tick)

The American Dog tick is probably the most medically important tick in the United States and is the primary vector of Rocky Mountain spotted fever in the East. It also transmits tularemia and may cause tick paralysis (Harwood and James, 1979). The preferred host of the adult is the domestic dog, but it readily bites man. It occurs throughout the United States (except the Rocky Mountain region) and frequently is encountered in Mississippi.

Mississippi distribution: Benton, Choctaw, Coahoma, Clay, Forrest, George, Greene, Grenada, Hinds, Jackson, Jefferson, Lafayette, Marshall, Monroe, Noxubee, Oktibbeha, Pearl River, Prentiss, Tishomingo, Winston and Yazoo counties.

Mississippi seasonal occurrence: April through September.

Mississippi hosts: Bob white quail, cardinal, cat, cotton mouse, cottontail rabbit, dog, eastern wood rat, gray squirrel, hispid cotton rat, marsh rice rat, opossum, raccoon, white-tailed deer, and white-footed mouse.

Diagnostic characteristics of the species: Coxa I deeply bifed; spiracular plate with a distinct dorsal pointed projection.

Voucher specimens: Rocky Mountain laboratories accession number 060563.

Haemaphysalis leporispalustris
(Rabbit tick)

The Rabbit tick is a small tick that is an important parasite of rabbits and ground birds and is distributed widely throughout the United States. It seldom bites man but may be important in transmitting several diseases from mammal populations to bird populations, and vice versa.

Mississippi distribution: Forrest, Jackson, Jasper, Marshall, Oktibbeha, and Tishomingo counties.

Mississippi seasonal occurrence: April to September.

Mississippi hosts: Cottontail rabbit and swamp rabbit.

Diagnostic characteristics of the species: Inornate ticks, eyes absent, festoons present, dentition of hypostome 3/3.

Voucher specimens: Mississippi Entomological Museum, MSU (MEM #8-7).

Ixodes brunneus
(No Common Name)

Ixodes brunneus is a bird tick that occurs in North America, Europe and Africa. Distribution is sparse, and it is found mostly on migratory birds.

Mississippi distribution: Newton, Scott and Oktibbeha counties.

Mississippi seasonal occurrence: February.

Mississippi hosts: Blackbird.

Diagnostic characteristics of the species: Females and males with spurs on trochanters, internal and external spurs on Coxa I approximately equal in size.

Voucher specimens: Rocky Mountain laboratories accession number 058169.

Ixodes cookei
(No Common Name)

Ixodes cookei is distributed generally throughout the United States, and it parasitizes a wide range of medium sized mammals. It rarely bites people and is unimportant as a transmitter of human disease.

Mississippi distribution: Clay and Oktibbeha counties.

Mississippi seasonal occurrence: February to June.

Mississippi hosts: Dog and mink.

Diagnostic characteristics of the species: Female palps thick and club-like. Male and female internal spurs of Coxa I long and thin.

Voucher specimens: Rocky Mountain laboratories accession number 035037.

Ixodes dentatus
(No Common Name)

Ixodes dentatus is an important parasite of rabbits, but it also has been reported from other small mammals and birds (Lancaster, 1973). It commonly occurs in the eastern United States and is not known to transmit human diseases.

Mississippi distribution: Marshall County. The location and specific collecting dates are not given, but this tick also has been reported from Mississippi by Andrews et al. (1980).

Mississippi seasonal occurrence: Unknown.

Mississippi hosts: Rabbit.

Diagnostic characteristics of the species: Female auriculae as posteriorly directed protuberances. Male internal spur of Coxa I very long and thin.

Voucher specimens: Mississippi Entomological Museum, MSU (MEM #8-6).

Ixodes kingi
(The Rotund tick)

The Rotund tick is of no known economic importance except as a parasite of dogs and certain fur-bearing mammals.

Mississippi distribution: This species has been collected in Mississippi, but the date and locality are unknown (Bishopp and Trembley, 1945).

Mississippi seasonal occurrence: Unknown.

Mississippi hosts: Unknown.

Diagnostic characteristics of the species: Female palps thick and club-like; male and female with internal spur. of Coxa I only moderately long not usually overlapping Coxa II.

Voucher specimens: None available.

Ixodes scapularis
(Black Legged tick)

The Black Legged tick commonly is encountered during the winter months in Mississippi. It parasitizes many species of mammals, especially deer, and occurs throughout the eastern and southeastern United States. This species is not known to be important transmitter of disease to man.

Mississippi distribution: Adams, Bolivar, Chickasaw, Choctaw, Copiah, Forrest, Franklin, George, Greene, Hancock, Harrison, Holmes, Jackson, Jasper, Jefferson, Jones, Marion, Noxubee, Oktibbeha, Pearl River, Perry, Scott, Stone, Wayne, Wilkinson, Tishomingo and Yazoo counties.

Mississippi seasonal occurrence: November through May.

Mississippi hosts: Deer, dog, horse, raccoon, rabbit and cattle.

Diagnostic characteristics of the species: Female palps longer than wide, auriculae reduced or inapparent; male with long, thin internal spur on Coxa I.

Voucher specimens: Rocky Mountain laboratories accession number 058672.

Ixodes texanus
(Raccoon tick)

The Raccoon tick is an important parasite of raccoons. It is distributed widely throughout the United States but was reported only recently from Mississippi (Goddard and Norment, 1983b). It is not known to transmit disease to humans.

Mississippi distribution: Marshall County.

Mississippi seasonal occurrence: March through August.

Mississippi hosts: Cottontail rabbit, raccoon and white-footed mouse.

Diagnostic characteristics of the species: Coxa I spurs on male and female reduced or absent; palps thick and club-like.

Voucher specimens: Rocky Mountain laboratories accession number 065923.

Rhipicephalus sanguineus
(Brown Dog tick)

The Brown Dog tick feeds almost exclusively on canines and is economically important because it occurs in extremely large numbers in and around homes with pet dogs. This species is irregularly distributed throughout the United States but is common in all sections of Mississippi. It does not bite man readily; however, it has potential for transmitting 11 diseases to man or animals (Miller, 1947).

Mississippi distribution: Coahoma, Forrest, Harrison, Hinds, Jackson, Jasper, Lafayette, Madison, Marshall, Oktibbeha, Prentiss and Tishomingo counties.
Madison, Marshall, Prentiss and Tishomingo counties.

Mississippi seasonal occurrence: March through October.

Mississippi hosts: Dog.

Diagnostic characteristics of the species: Usually inornate, eyes and festoons present, coxa I deeply cleft. Spiracular plates comma shaped.

Voucher specimens: Mississippi Entomological Museum, MSU (Mem # 8-5).

Glossary of Terms Used IN The Key [a]

Anterior: Toward the front end.

Capitulum: Anterior movable portion of body of hard ticks, including basis capituli, palps, hypostome and chelicerae of hard ticks. Located ventrally in adults and engorged nymphs of soft ticks, anteriorly in larvae.

Chelicerae: Paired structures lying dorsally to the hypostome, which complete the cylindrical mouth parts that are inserted when the tick feeds.

Chitinous tubercles: Small, chitinized, rounded lobes on the posterointernal angle of the festoons of *Amblyomma cajennense* and sometimes *A. maculatum*.

Cornua: Small projections extending from the dorsal, posterolateral angles of the basis capituli.

Coxae: (sing. Coxa) Small, sclerotized plates on the venter representing the first segment of the leg to which the trochanters are movably attached. From anterior to posterior, the coxae are designated by Roman numerals I, II, III and IV. Bifed coxae are those that are cleft, divided or forked.

Denticles: Small, recurved projections or "teeth" on the ventral side of the hypostome. (See dentition.)

Dentition: Refers to the presence of denticles on the ventral side of the hypostome. The numerical arrangement of the files or rows of denticles is expressed by the dentition formulas. Thus, dentition 3/3 means that there are three longitudinal rows of denticles on each side of the median line of the hypostome.

Dimorphism: Difference in form, color, etc., between individuals of the same species, more particularly between sexes.

Distal: Farthest from the point of attachment or origin.

Dorsal: Pertaining to the back or top of the body.

Dorsum: The upper surface of the body.

Engorged: Enlargement or distention of a tick following a blood meal. Since the scutum is short in the larva, nymph, and female hard tick (covering about half the dorsal surface in the unfed specimen), the body is capable of pronounced distention. As the body fills with blood, the relative size of the scutum is reduced. In a fully engorged female hard tick, the scutum may appear only as a small plate on the anterior of the body. In the soft tick, the scutum is absent and both sexes may become enlarged, although not usually to the extent of the engorged female hard tick.

Festoons: Uniform rectangular areas, separated by distinct grooves, located on the posterior margin of most genera of the hard ticks. Very distinct areas in unengorged specimens but may not be visible in fully engorged females.

Files: Longitudinal rows of denticles or "teeth" on the ventral surface of the hypostome.

Genital aperture: External opening of the genital organs. Located anteriorly on the ventro-median line, posterior to the basis capituli.

Hypostome: Median ventral structure of the mouth parts that lies parallel to

[a]Taken in part from Strickland, et al., 1976, *Ticks of Veterinary Importance.* USDA Agricultural Handbook No. 485.

and between the palps and are immovably attached to the basis capituli. It bears recurved "teeth" or denticles (See dentition.)

Inornate: Absence of a color pattern on the scutum.

Integument: Outer covering or cuticle of the tick's body.

Legs: Segmented appendages of which nymphs and adults have four pair and larvae have three pair. From anterior to posterior, the legs are identified by Roman numerals I, II, III and IV. The segments from the proximal (next to the body) to the distal end are called coxa, trochanter, femur, tibia, metatarsus and tarsus.

Median: Toward the median axis of the body.

Ornamentation: Enamel-like color pattern that is superimposed on the base color of the integument in hard ticks. When present, this color pattern may be white to dirty white in *Dermacentor* or may be an intense copper or bronze color with touches of yellow or green in some *Amblyomma*.

Media: Toward the median axis of the body.

Median: The longitudinal axis that divides the body.

Palps or palpi: Paired articulated appendages located anterolaterally upon the basis capituli and lying parallel with the hypostome. Four distinct segments are present in soft ticks. In all hard ticks the fourth segment is reduced to a small hair-crowned papilla lying in a cuplike depression of segment 3. The sequence of numbering of the segments is indicated by Arabic numerals 1, 2, 3 and 4: 1 being the proximal segment (closes to the basis capituli).

Posterior: Toward the rear end.

Protuberance: Any elevation above the surface.

Scutum: The sclerotized dorsal plate posterior to the capitulum in hard ticks. It covers almost the entire dorsal surface in the male, about one half the dorsal surface in the unengorged female. (See engorged.)

Spiracular plates: Paired plates located ventrolaterally and posterior to coxa IV in hard ticks; may be oval, rounded or comma-shaped. In the soft ticks the spiracular plates are located ventrolaterally and opposite coxa IV and are usually round or oval. They are the external evidence of the respiratory system.

Spurs: Coxal spurs are projections from the posterior surface or posterior margin of the coxae; may be rounded or pointed, small or large. Projections on the median side are called internal spurs; those on the lateral side are called external spurs. Metatarsal spurs are small, pointed projections on the distal end of the metatarsus. Spurs also may be found on the palps of some species.

Tarsus: The terminal leg segment.

Acknowledgments

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HERBICIDES FOR GRASS CONTROL IN NO-TILL PLANTED Soybeans

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HERBICIDES FOR GRASS CONTROL IN NO-TILL PLANTED SOYBEANS

The increase in soybean acreage in North Mississippi in the past decade has resulted mainly from the conversion of pasture and idle land to soybean fields. About 40% of the land is rented (1).

The demand for increased cash flow dictates farming practices of the tenant. Therefore, large acreages of pasture and idle land with a natural tendency to erode are being exposed to further erosion when converted to cropland.

The Soil Conservation Service (SCS) advocates no-till planting as an effective erosion-reduction practice. Consequently, farmers are encouraged to reduce or eliminate preplant tillage on sloping land if possible. By using no-till planting practices, producers can plant soybeans on land with a 5 to 8% slope without increasing erosion. Research at the MAFES North Mississippi Branch has resulted in an annual savings of 8 tons of soil per acre by planting soybeans no-till on a Grenada silt loam soil with a 5% slope (2).

An estimated 85% of the fields of North Mississippi are infested with johnsongrass and bermudagrass. Where perennial grasses are a problem, the SCS advises that growers not use no-till planting or delay adoption of the practice until the grasses are controlled. Consequently, even though no-till planting would reduce erosion, it may not be suitable where perennial grasses are common.

The studies reported herein evaluated over-the-top applications of herbicides for control of johnsongrass. The first study (Part I) compared the efficacy of herbicides applied over-the-top for johnsongrass control in soybeans planted no-till and cultivated. The second study (Part II) compared preemergence and over-the-top herbicide treatments for control of annual weeds, grasses and johnsongrass in soybeans planted no-till and grown with and without cultivation.

Part I

This study was conducted at the MAFES North Mississippi Branch in 1979, 1980 and 1981. The herbicides used can be safely sprayed over-the-top of soybeans without causing injury.

A site was selected on an eroded Grenada silt loam (6% slope) with a heavy infestation of rhizome johnsongrass. Eight herbicide treatments, an early cultivated treatment and a weedy check were located so that each treatment could be continued in the same area for the duration of the study. The treatments were arranged in a randomized complete block design with four replications. Herbicides, rates and application dates for 1979, 1980 and 1981 are presented in Table 1.

In 1979, Roundup® (glyphosate) at 1.0 lb/acre was applied to plots treated with Vistar 2S® (mefluidide) + X-77®, and paraquat at 0.5 lb/acre was applied to all other plots at planting. In 1979 and 1980, paraquat at 0.5 lb/acre was applied broadcast to all plots at planting as a burn-down treatment.

Forrest soybeans were planted June 11, 1979; May 14, 1980 and June 11, 1981. Plots were no-till planted with a John Deere 7000® planter equipped with fluted coulters. Fertilizer at the rate of 300 lbs/acre of 0-20-20 was applied 2 inches deep and 2 inches to the side of the row at planting. Plots consisted of four rows 50 ft long with 40 inch spacing.

All plots except the weedy check were cultivated twice in each growing season. Basagran® at 0.75 lb/acre was applied over-the-top to all plots about three weeks after planting for control of cocklebur.

Herbicides were applied in water at 20 gal per acre, using a tractor-mounted boom with nozzles spaced 20 inches apart. Johnsongrass was 24 inches tall when herbicides were applied in 1979 and 1981, 15 inches in 1980. Repeat treatments were made to six-inch regrowth.

Visual ratings for johnsongrass control (0 = no control, 100 = death) were made during the growing season. The two center rows of each plot were harvested with a plot combine.

Results and Discussion

1979

Johnsongrass control with Poast® (sethoxydim) on July 18 ranged from 60% with 0.5 lb/acre to 83% with 1.0 lb/acre (Table 2). Johnsongrass control with Poast on September 25 ranged from 18 (Treatment 1) to 68% (Treatment 5) with one application and was 75 (Treatment 6) and 84% (Treatment 3) with two applications. No additional benefits were measured for the higher rate of Poast when two applications were made.

Johnsongrass control with Vistar was 5 (Treatment 7) and 15% (Treatment 8) on July 18; 13 (Treatment 8) and 43% (Treatment 7) on September 25. A second application of Treatment 8 was made but did not control johnsongrass in this study.

Annual grass control with the Poast treatments ranged from 85 (Treatment 1) to 91% (Treatment 4) on July 18. The first cultivation was delayed because the plots were too wet. Vistar alone and cultivation alone did not control annual grasses or johnsongrass at mid-season. Cultivation alone appeared to reduce yields.

Grain yields were low because of the low productivity level of the soil. There were no significant differences in grain yields among Poast treatments.

1980

Experimental herbicides were substituted for some of the Poast treatments that were used in 1979. All herbicides were applied twice at the same rate.

Johnsongrass control with Poast was slightly better on July 11 than on September 16 (Table 3). RO 13-8895 and Assure® provided excellent seasonal control and were equal or superior to Poast. Control of johnsongrass with Vistar was only 20% on July 11 and 32% on September 16.

Table 1. Over-the-top herbicide treatments evaluated for control of annual grasses and johnsongrass in soybeans planted no-till on a Grenada silt loam (6% slope) at the MAFES North Mississippi Branch, 1979, 1980 and 1981.

1979		1980[3]		1981	
Herbicide	Broadcast Rate	Herbicide	Broadcast Rate	Herbicide	Broadcast Rate
	lb ai/acre % v/v		lb ai/acre % v/v		lb ai/acre % v/v
Poast 1.53 E® + Atplus 411 F®[1]	0.5 1.25	Poast 1.53 E® + Atplus 411 F[3]	0.5 1.25	Poast 1.53 E[6] + Atplus 411 F	0.5 1.25
Poast 1.53 E + Super Savol®[1]	0.5 1.25	Poast 1.53 E + Super Savol[3]	0.5 1.25	Poast 1.53 E[6] + Super Savol	0.5 1.25
Poast 1.53 E + Super Savol[2]	0.5 1.25	RO 13-8895 3E[3,4] + X-77	0.5 0.25	KK-80 4E[6,8] + X-77	0.5 0.25
Poast 1.53 E + Atplus 411 F[1]	1.0 1.25	RO 13-8895 3E[3] + Super Savol	0.5 1.25	KK-80 4E[6] + Super Savol	0.5 1.25
Poast 1.53 E + Super Savol[1]	1.0 1.25	RO 13-8895 3E[3] + X-77	0.25 0.25	NCI 96721 1.3 E[6,8] + X-77	0.5 0.25
Poast 1.53 E + X-77®[2]	1.0 1.25	Assure 0.9 E®[3,5] + X-77	0.25 0.25	RO 13-8895 3E[6] + X-77	0.25 0.25
Vistar 2S®[1] + X-77	0.25 0.25	Assure 0.9 E[3] + X-77	0.5 0.25	Assure 0.9 E[6] + X-77	0.5 0.25
Vistar 2S®[2] + X-77	0.25 0.50	Vistar 2S[3] + X-77	0.25 0.5	Vistar 2S[7] + X-77	0.35 0.5
Cultivated Check	---	Cultivated Check	---	Cultivated Check	---
Weedy Check	---	Weedy Check	---	Weedy Check	---

[1]Herbicides applied June 25; johnsongrass plants 24 inches tall.
[2]Herbicides applied June 25; repeated July 23; johnsongrass plants 24 inches tall; regrowth 6 inches
[3]Herbicides applied June 3; repeated June 30; johnsongrass plants 15 inches tall; regrowth 6 inches
[4]Development discontinued after 1980
[5]Tested under code NCI 96683
[6]Herbicides applied July 8; repeated August 4; johnsongrass plants 24 inches tall; regrowth 6 inches
[7]Herbicides applied June 26; repeated July 8 and July 24
[8]Development discontinued after 1981

Table 2. Control of annual grasses and johnsongrass with over-the-top herbicides and grain yield of soybeans planted no-till on a Grenada silt loam (6% slope), by treatment, MAFES North Mississippi Branch, 1979.

Treatment	Herbicide	Broadcast Rate	Estimated Control[1] 7-18 Annual Grasses	7-18 Johnsongrass	9-25 Johnsongrass	Grain Yield
		lb ai/acre % v/v	----------%----------			bu/acre
1	Poast 1.53 E® + Atplus 411 F®	0.5 1.25	85a	60 b	18 cd	14.8ab
2	Poast 1.53 E + Super Savol®	0.5 1.25	91a	80ab	53ab	21.3a
3	Poast 1.53 E + Super Savol[2]	0.5 1.25	88a	80ab	84a	21.2a
4	Poast 1.53 E + Atplus 411 F	1.0 1.25	91a	83a	55ab	17.0ab
5	Poast 1.53 E + Super Savol	1.0 1.25	90a	75ab	68ab	16.8ab
6	Poast 1.53 E[2] + X-77®	1.0 1.25	90a	73ab	75ab	20.7a
7	Vistar 2S® + X-77	0.25 0.25	15 c	5 d	43 bc	11.8ab
8	Vistar 2S + X-77	0.25 0.50	48 b	15 c	13 d	17.3ab
9	Cultivated Check	---	0 c	0 d	15 d	8.6 b
10	Weedy Check	---	0 c	0 d	0 d	11.0ab

[1]Visually estimated...0 = no control; 100 = death. Means in a column followed by the same letter are not different (P < .05) according to Duncan's Multiple Range Test.
[2]Applied a second time when johnsongrass regrowth was about 6 inches.

As in 1979 yields were low but still were generally reflective of johnsongrass control.

1981

The first seven treatments were applied July 8 and repeated on August 4. Vistar (Treatment 8) was applied July 8 and repeated each time that johnsongrass reached eight inches in height---a total of three applications during the growing season.

Treatments 1-7 gave excellent johnsongrass control but yields among treatments varied appreciably (Table 4). This was attributed to the eradication of rhizome johnsongrass in some plots by continuous use of effective over-the-top grass herbicides.Seasonal johnsongrass control with Vistar was no better in 1981 than in 1979 or 1980 and was improved only slightly by making a second application. Grain yield did not differ significantly for treatment with Vistar and cultivation only.

Cultivation alone was not an effective practice for johnsongrass control. In some instances the crop was physically damaged by cultivation.

Conclusions

Johnsongrass can be controlled with postemergence herbicides in soybeans planted no-till. Effective control is dependent on proper herbicides and timely applications. Two applications were necessary for effective seasonal johnsongrass control with the postemergence herbicides. Johnsongrass control with postemergence herbicides appeared to be influenced more by a timely follow-up treatment than by excessively high application rates. Cultivation alone did not prove to be an effective johnsongrass control measure with no-till planting. Soybean grain yields generally were improved by controlling johnsongrass.

Table 3. Control of annual grasses and johnsongrass with over-the-top herbicides and grain yield of soybeans planted no-till on a Grenada silt loam (6% slope), by treatment, MAFES North Mississippi Branch, 1980.

Treatment	Herbicide	Broadcast Rate	Estimated Control[1] 7-11 Annual Grasses	7-11 Johnsongrass	9-16 Johnsongrass	Grain Yield
		lb ai/acre % v/v	%			bu/acre
1	Poast 1.53 E® + Atplus 411 F®	0.5 1.25	84a	85ab	67abc	13.0ab
2	Poast 1.53 E + Super Savol®	0.5 1.25	73a	87a	85a	16.5ab
3	RO 13-8895 3E + X-77®	0.5 0.25	43ab	55 b	72ab	11.2abc
4	RO 13-8895 3F + Super Savol	0.5 1.25	46ab	58 b	65abc	19.0a
5	RO 13-8895 3E + X-77	0.25 0.25	55ab	77ab	85a	16.8ab
6	Assure 0.9 E® + X-77	0.25 0.25	73a	87a	93a	14.4ab
7	Assure 0.9E + X-77	0.5 0.25	94a	97a	83a	14.4ab
8	Vistar 2S® + X-77	0.25 0.5	0 b	20 c	32 bcd	9.7abc
9	Cultivated Check	---	0 b	0 c	23 cd	7.9 bc
10	Weedy Check	---	0 b	0 c	0 d	3.6 c

[1]Visually estimated...0 = no control; 100 = death. Means in a column followed by the same letter are not different (P < .05) according to Duncan's Multiple Range Test.

Table 4. Control of annual grasses and johnsongrass with over-the-top herbicides and grain yield of soybeans planted no-till on a Grenada silt loam (6% slope), by treatment, MAFES North Mississippi Branch, 1981.

Treatment	Herbicide	Broadcast Rate	Estimated Control[1] 7-17 Annual Grasses	7-16 Johnsongrass	9-22 Johnsongrass	Grain Yield
		lb ai/acre % v/v	%			bu/acre
1	Poast 1.53 E® + Atplus 411 F®	0.5 1.25	69ab	79a	72 a	17.7 bc
2	Poast 1.53 E + Super Savol®	0.5 1.25	94a	93a	96a	27.9a
3	KK-80 4E + X-77®	0.5 0.25	44 bc	94a	87a	13.9 bcd
4	KK-80 4E + Super Savol	0.5 1.25	93a	95a	90a	24.1ab
5	NC1 96721 1.3E + X-77	1.0 0.25	15 c	88a	98a	16.5 bc
6	RO 13-8895 3E + X-77	0.25 0.25	15 c	73a	86a	14.0 bcd
7	Assure 0.9E + X-77	0.5 0.25	20 c	83a	86a	11.7 cd
8	Vistar 2S + X-77	0.35 0.5	0 c	25 b	33 b	7.1 cd
9	Cultivated Check	---	0 c	0 c	0 c	5.3 d
10	Weedy Check	---	0 c	0 c	0 c	5.5 d

[1]Visually estimated...0 = no control; 100 = death. Means in a column followed by the same letter are not different (P < .05) according to Duncan's Multiple Range Test.

Sencor® (metribuzin), Surflan® (oryzalin), Dual® (metolachlor) and Lasso® (alachlor) were compared in 1980, 1981 and 1982 as preemergence treatments for seedling grass control in soybeans planted no-till. In conjunction with these preemergence herbicides, postemergence herbicides applied directed and over-the-top were evaluated for rhizome johnsongrass control. The PRE and POST treatments are described in Table 5.

The experiment was conducted on a Grenada silt loam (2% slope). A well-established uniform stand of johnsongrass was present on the site at the beginning of the study. The experiment was designed so that each treatment could be continued in the same area for the duration of the study. Each plot was eight rows 32.5 feet long with 40 inch spacing. The experimental design was a split plot with four replications. Four adjacent rows within each plot were randomly selected for cultivation each year.

A conventionally prepared seedbed treatment with Treflan® (trifluralin) at 0.75 lb a.i./acre applied preplant incorporated (PPI) and Sencor at 0.375 lb a.i./acre applied preemergence (PRE) was used as a standard each year. The seedbed preparation for the conventional plot consisted of early disking, chiseling and late disking while applying PPI, followed by an additional disking and one pass through the field with a seedbed conditioner before planting. Preemergence sprays were applied at planting.

No-till planting was directly into the previous years' soybean stubble. A broadcast application of Roundup or paraquat mixed with a residual preemergence herbicide was made to the no-till plots at planting (Table 5). Fertilizer (300 lb/acre of 0-20-20) was applied 2 inches deep and 2 inches to the side of the seed drill at planting. Forrest soybeans at the rate of 60 pounds per acre were planted with a John Deere 7000 no-till planter on May 15, June 12 and May 20 in 1980, 1981 and 1982, respectively.

The over-the-top sprays were applied in water at 20 gallons per acre using a tractor-mounted, four row boom with nozzles spaced 20 inches apart when johnsongrass reached an average of 15 to 20 inches in height. Directed spray treatments were made to a 14-inch band with a two-row fender, cultivator applicator when soybeans reached eight inches. Two cultivations were made in four adjacent rows of each plot during the growing season. Two applications of Basagran (bentazon) were applied each year to control cocklebur. The two center rows of each cultivated and non-cultivated plot were harvested with a plot combine.

Results

Annual grasses and seedling johnsongrass were not major pests in this study. The preemergence herbicides gave satisfactory annual grass control except in 1980 when Sencor (Treatment 1) and Surflan (Treatment 2) gave significantly less control ($P<.05$) with and without cultivation (Table 6) than did conventional seedbed preparation (Treatment 6). However, control ratings were made early in 1980, and additional control likely would have been attained with POST applications to these plots.

Control of johnsongrass varied among treatments within years (Table 6). Control with Treatments 3, 4 and 5 applied to cultivated and uncultivated plots in the last year of the study was equal to the control

Table 5. Preemergence and postemergence herbicides evaluated for control of annual grasses and johnsongrass in soybeans planted no-till on a Grenada silt loam (2% slope) at the MAFES North Mississippi Branch, 1980, 1981 and 1982.

	Preplant Treatment		Postemergence Treatment					
			1980		1981		1982	
Treatment	Herbicide	Broadcast Rate	Herbicide	Broadcast Rate	Herbicide	Broadcast Rate	Herbicide	Broadcast Rate
		lb ai/A %v/v		lb ai/A %v/v		lb ai/A %v/v		lb ai/A %v/v
1	Roundup 4E® + Sencor 4L®	1.0 0.375	Paraquat 2E + X-77 (Dir)	0.125	Paraquat 2E + X-77 (Dir)	0.125 0.5%	Paraquat + X-77 (Dir	0.125 0.5%
2	Paraquat 2E® + X-77® + Surflan 4AS®	0.25 0.5% 1.0	Lorox 50W + X-77 (Dir)	0.75 0.5%	Lorox 50W + X-77 (Dir)	0.75 0.5%	Lorox 50W +X-77 (Dir)	0.75 0.5%
3	Paraquat 2E + X-77 + Dual®	0.25 0.5% 2.0	KK-80[1] + X-77	0.375 0.25%	Assure 0.9E®[2] + X-77	0.15 0.5%	Fusilade 4E® + Atplus	0.3 1.25%
4	Paraquat 2E + X-77 + Lasso 4E	0.25 0.5% 2.0	Poast 1.5E® + Atplus®	0.375 1.25%	Poast 1.5E + Atplus	0.3 1.25%	Poast 1.5E + Atplus	0.3 1.25%
5	Paraquat 2E + X-77 + Lasso 4E	0.25 0.5% 3.0	Poast 1.5E + Atplus	0.375 1.25%	Poast 1.5E + Atplus	0.3 1.25%	Whip 1E®[3]	0.15
6	Treflan 4E® Sencor 4L	0.75 PPI 0.375 PRE	None		None		None	

[1]Discontinued development after 1980.
[2]Tested under code NCI 96683 and OPX-Y 6202.
[3]Tested under the code HOE 33171.

where conventional seedbed preparation (Treatment 6) was used. Control in 1980 with Treatment 5 applied to cultivated soybeans and Treatments 4 and 5 applied to uncultivated soybeans was better than where conventional seedbed preparation was used. Only Treatment 3 applied to cultivated plots and Treatment 5 applied to uncultivated plots gave control as good as where conventional seedbed preparation was used in 1981. Late-season control with Roundup used as a burn-down at planting and paraquat used as a directed spray (Treatment 1) and paraquat used as a burn-down and Lorox as a directed spray (Treatment 2) was not acceptable.

The lack of control of johnsongrass on the conventionally prepared seedbeds in 1980 was attributed to drought, which prevented effective competition by soybeans. Among the factors contributing to the excellent overall seasonal control of johnsongrass on the conventionally tilled plots in 1981 and 1982 were that (1) the seedbeds were prepared in early spring and some rhizomes were killed by exposure and (2) soybeans were planted late in 1981 and the later disking further reduced early competition by johnsongrass.

Table 6. Control of annual grasses and johnsongrass with preemergence and postemergence herbicides applied to soybeans planted no-till on a Grenada silt loam (2% slope) at the MAFES North Mississippi Branch, 1980, 1981 and 1982.

Treatment	Cultivated						Uncultivated					
	Annual Grasses[2]			Johnsongrass[2]			Annual Grasses[2]			Johnsongrass[2]		
	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982
	%											
1	91 b	93a	94a	0 b	34 c	30 b	60 b	85a	96a	0 b	25 c	25 b
2	84 b	91a	94a	0 b	25 c	15 b	58 b	83a	96a	0 b	10 c	15 b
3	95a	94a	94a	24 b	79ab	91a	91a	94a	92a	24 b	68 b	94a
4	95a	95a	96a	20 b	59 bc	98a	91a	95a	91a	71a	55 b	95a
5	94a	91a	95a	66a	74 b	94a	91a	94a	90a	93a	70ab	92a
6	95a	95a	91a	24 b	90a	84a	95a	94a	93a	20 b	76a	86a

Means in a column followed by a common letter are not significantly different at the 0.5 level according to Duncan's Multiple Range Test.

[1]Cultivated June 3 and June 2, 1980; July 7, 1981 and June 11 and June 23, 1982.
[2]Evaluations of AG, June 16; JG, September 9, 1980.
Evaluations of AG, August 5; JG, September 25, 1981
Evaluations of AG, July 28; JG, September 8, 1982.

Table 7. Grain yield response of soybeans to preemergence and postemergence herbicides applied to soybeans planted no-till on a Grenada silt loam (2% slope), by treatment, with and without cultivation, MAFES North Mississippi Branch, 1980, 1981 and 1982.

Treatment Number	Grain Yields					
	Cultivated			Uncultivated		
	Bu/A			Bu/A		
	1980	1981	1982	1980	1981	1982
1	24.6 b	11.9 b	17.9 b	18.7 b	11.9 b	20.4 b
2	22.8 b	11.2 b	16.4 b	18.4 b	11.2 b	20.6 b
3	24.7 b	16.7 b	35.6a	15.6 b	13.5 b	36.8a
4	22.4 b	13.6 b	34.5a	23.1 b	13.6 b	35.7a
5	23.3 b	17.6 b	32.9 b	19.5 b	14.6 b	36.7a
6	28.5a	29.5a	40.1a	26.7a	34.6a	38.8a

Means in a column followed by a common letter are not significantly different at the .05 level according to Duncan's Multiple Range Test.

Yields on cultivated and uncultivated plots were highest on the conventionally prepared seedbeds each year (Table 7). However, yields from this treatment in the last year of the study were not significantly higher ($P^{s}.05$) than yields from Treatments 3 and 4 with cultivation and Treatments 3, 4 and 5 without cultivation.

In Treatment 6 (Table 7), yields were significantly higher than in Treatments 1-5 in 1980 and 1981 in the cultivated and uncultivated plots. In 1982 yields were lower where directed sprays (Treatments 1 and 2) were used to control johnsongrass in the uncultivated plots than where over-the-top herbicides were used. The greater control of rhizome johnsongrass improved the relative yields of soybeans at the end of the three years in the plots without seedbed preparation.

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Field Evaluation of Postemergence Herbicides For Virginia Buttonweed Control in Turf

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Field Evaluation of Postemergence Herbicides for Virginia Buttonweed Control in Turf

Virginia buttonweed (*Diodia virginiana* L.) conforms distinctly to many of the characteristics considered undersirable in turf; consequently making it a weed (Figure 1). It disrupts turf uniformity due to a substantially different leaf width, leaf shape, growth habit and/or color. It is a strong competitor in common bermudagrass [*Cynodon dactylon* (L.)Pers.,] and other warm-season species. Add to this an apparent high degree of tolerance to commonly used herbicides, particularly postemergence herbicides, and one can easily place buttonweed in the 'problem weed' category.

Virginia buttonweed is a spreading, usually pubescent (leaves), warm-season perennial with branched stems 4-24 inches long. Leaves of buttonweed are opposite, sessile, broader at the base and tapering toward the end (elliptic - laneolate) and 0.5 to 3 inches long. The flower is usually white with one to three in each leaf axil or two to six per node. The fruit is pubescent, oblong in shape, about .25 inches long and prominently ridged (1,2).

Virginia buttonweed is evident throughout the South from late spring until frost in lawns, golf courses, moist pastures, ditches and waste areas. We have observed isolated incidences of Virginia buttonweed on golf-course greens mowed regularly at 0.25 inches or less. However, Virginia buttonweed's ability to be competitive in this situation has not been studied.

Virginia buttonweed is a member of the Rubiaceae (Madder) family, which includes 10 genera and 50 plus species. Among the genera of the Rubiaceae are bedstraw (*Galium*), bluets (*Hedyotis* and *Houstonia*), field madder (*Sherardia* and Florida pusley (*Richardia scabra* L.). Poorjoe (*Diodia teres* Watt.) is similar to Virginia buttonweed but is an annual. The stems and leaves of poorjoe are less coarse, and the seed pods are smaller than those of Virginia buttonweed (1). Poorjoe apparently is not a serious problem in high-maintenance turfgrassses but is found on roadsides and pastures.

Preliminary work in 1974 indicated that the rate(s) of 2,4-D or mixtures containing 2,4-D as a single application necessary to achieve fair to good control of Virginia buttonweed were too high to maintain adequate turfgrass (common bermudagrass) quality.

The primary objective of the work reported here was to determine postemergence herbicide efficacy on Virginia buttonweed. Tolerance of common bermudagrass to these treatments also was evaluated.

Materials and Methods

Phenoxy/Dicamba Combinations

Our objective in these studies was to evaluate 2,4-D or herbicide combinations containing 2,4-D for Virginia buttonweed control under field conditions. Specifically we evaluated 2,4-D alone, 2,4-D + dicamba and 2,4-D + mecoprop (MCCP) + dicamba.

Studies were conducted in 1979 at Northwood Country Club, Meridian; MSU Golf Course, Starkville and Bel Air Country Club, Tupelo. All plots were in common bermudagrass turf maintained as golf-course fairway (0.5 inch mowing height).

Plots were 3 x 20 feet arranged in a randomized complete block design replicated four times. Herbicide applications were made with a compressed-air bicycle sprayer. Spray volume was 30 gpa, including 0.25% nonionic surfactant (Multi Film X-77®). Application rates, intervals and number of applications are summarized in Tables 1-5.

Weed-control and turf-tolerance ratings were made at about 14-day intervals following treatment. A scale of 0 to 100 was used with 0 = no control or no turf injury and 100 = complete control of buttonweed or complete turf kill. We assessed control of Virginia buttonweed as excellent (90 or higher), good (80 or better), marginal (70 to 80) or unacceptable (below 70). Turf injury was considered to be unacceptable if the average rating exceeded 25 (25% injury).

2,4-D/Dicamba Ratios

Experiments were conducted in 1980 and 1981 to evaluate the efficacy of different dicamba ratios.

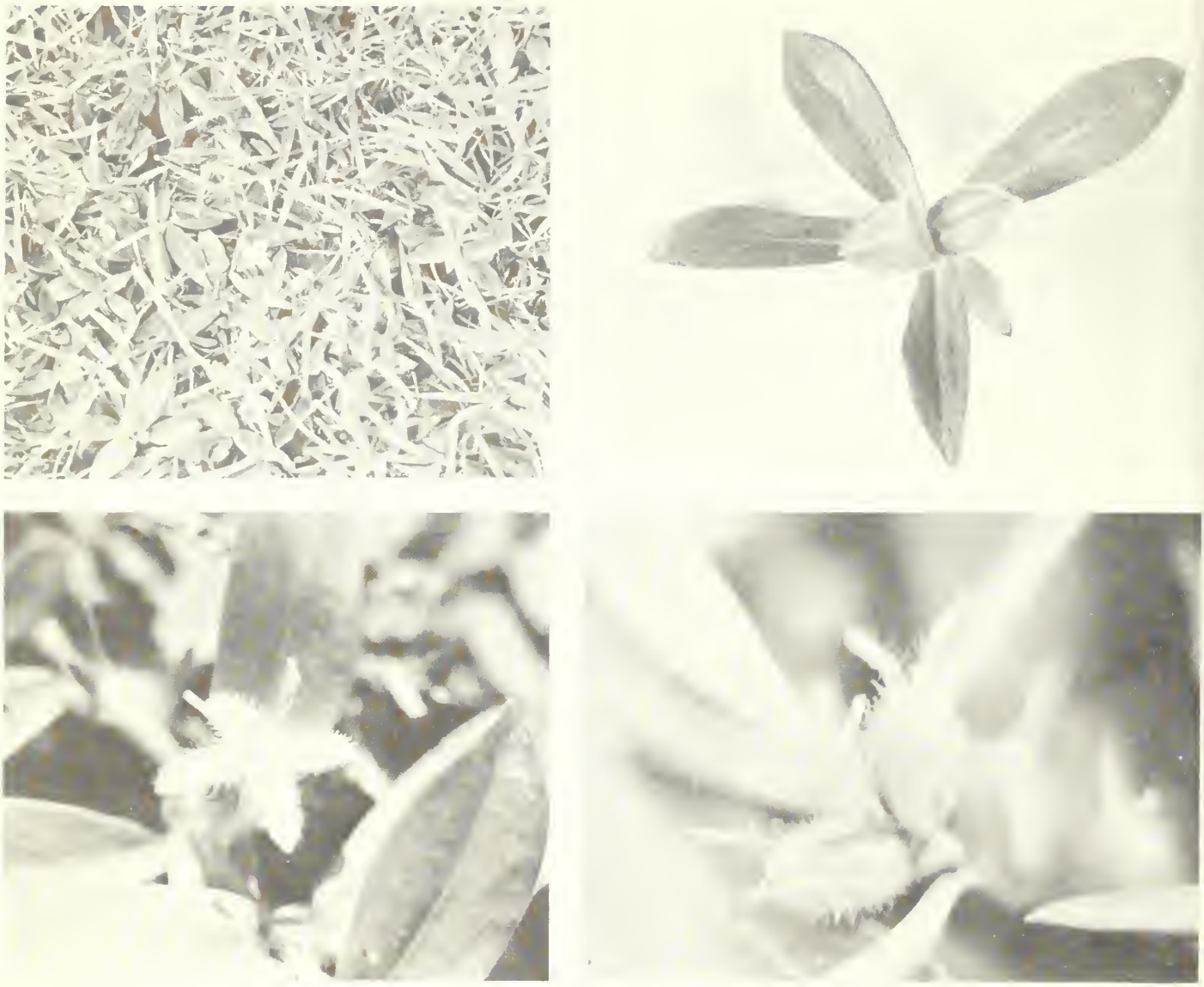

Figure 1. Virginia buttonweed: (A) mature plants in common bermudagrass turf, (B) seedlings - opposite, sessile leaves, (C) white flower (corolla) with inner (upper) surface pubscent, and (D) pubscent, ridged fruit (seed).

These studies were conducted at the MSU Golf Course, Starkville and Columbus Country Club, Columbus.

Our objective was to determine the effect of varying the amount of dicamba in the 2,4-D + dicamba mix on Virginia buttonweed control. Dicamba rates evaluated in combination with 1 lb/acre 2,4-D were 0.50, 0.25, 0.17, 0.12, 0.06 and 0.03 lb/acre. These combinations were compared to 2,4-D (1 lb/acre) or dicamba (0.25 and 0.50 lb/acre) alone.

Application techniques, application parameters and evaluations were the same as previously described.

Results and Discussion

Phenoxy/Dicamba Combinations

Results of studies at all three locations were essentialy the same. Only the data from the Bel Air Country Club are presented (Tables 1,2, and 3).

Virginia buttonweed control with 2,4-D alone was not acceptable (Table 1). The maximum level of control achieved with a normal use rate (1 lb/acre application) rerely exceeded 50%. Regrowth of Virginia buttonweed was observed within two to four weeks after the last application, except when four applications at biweekly intervals (1 lb/acre application) were used. The only significant turf injury occurred following a single application of 4 lb/acre. However, this injury was not observed two weeks later.

The herbicidal activity of 2,4-D + mecoprop + dicamba (Table 1), was better than that of 2,4-D alone (Table 1). The level and duration of control with the addition of mecoprop and dicamba (0.5 + .1 lb/acre) to 2,4-D (1 lb/acre) averaged about 20% better than with 1 lb/acre of 2,4-D alone.

Injury of the common bermudagrass turf was greater with the three-way combination than with 2,4-D alone. However, injury did not persist for more than two consecutive ratings (four weeks) unless the total amount of 2,4-D in the combination exceeded 4 lb/acre.

Virginia buttonweed control with 2,4-D + dicamba was better than with 2,4-D alone or the three-way combination (Table 3). The most striking difference was in the longer

Table 1. Effect of 2,4-D rate, application interval, and number of applications on Virginia buttonweed control at various time intervals after the initial treatment at Bel Air Country Club, Tupelo, MS. First application was made July 18, 1979.

2,4-D Rate	Days of application	Virginia Buttonweed Control[a], 9 DAIT	15 DAIT	30 DAIT	51 DAIT	72 DAIT	86 DAIT
(lb/A)		(%)					
1.0	1	47.5 d	12.5 d	00.0 d	00.0 d	00. d	00.0 c
1.0	1, 15	52.5 d	60.0 b	12.5 c	00.0 d	00.0 d	00.0 c
1.0	1, 30	47.5 d	10.0 d	17.5 b	10.0 cd	00.0 d	00.0 c
1.0	1, 15, 30	50.0 d	57.5 bc	75.0 ab	60.0 a	37.5 b	27.5 b
1.0	1, 30, 72	47.5 d	12.5 d	12.5 c	27.5 b	22.5 b	00.0 c
1.0	1, 15, 30, 51	52.5 d	62.5 b	72.5 b	67.5 a	65.0 a	47.5 a
2.0	1, 15	72.5 c	80.0 a	67.5 b	00.0 d	00.0 d	00.0 c
2.0	1, 30	80.0 b	50.0 c	82.5 a	15.0 c	05.0 d	00.0 c
4.0	1	90.0 a*	17.5 d	00.0 d	00.0 d	00.0 d	00.0 c
Check	0	00.0 e	00.0 e	00.0 d	00.0 d	00.0 d	00.0 c

[a] All means within a column followed by the same letter do not differ significantly according to DMRT at .05 level of probability. Control rating system; 0 = no control, 100 = complete control. DAIT = day after initial treatment

* Indicates unacceptable turf injury (25% or higher discoloration).

Table 2. Effect of 2,4-D + mecoprop (MCPP) + dicamba rate, application intervals, and number of applications on Virginia buttonweed control at various time intervals after the initial treatment at Bel Air Country Club, Tupelo, MS. First application was made July 18, 1979.

2,4-D[a] Rate	Days of application	Virginia Buttonweed Control[b], 9 DAIT	15 DAIT	30 DAIT	51 DAIT	72 DAIT	86 DAIT
(lb/A)		(%)					
1.0	1, 15	72.5 bcd	72.5 de	62.5 d	27.5 f	00.0 e	00.0 e
1.0	1, 30	65.0 d	47.5 f	75.0 bc	65.0 cd	32.5 d	17.5 d
1.0	1, 15, 30	65.0 d	75.0 cd	77.5 ab*	50.0 e	05.0 e	00.0 e
1.0	1, 30, 72	67.5 d	45.0 f	82.5 f	72.5 bcd	72.5 abc	65.0 b
1.0	1, 15, 30, 51	72.5 bcd	72.5 de	77.5 ab	80.0 ab*	65.0 c*	50.0 c*
2.0	1	80.0 ab*	65.0 e	35.0 e	12.5 g	00.0 e	00.0 e
2.0	1, 15	82.5 ab*	82.5 b	70.0 c*	32.5 f	00.0 e	00.0 e
2.0	1, 30	82.5 ab	65.0 e	80.0 ab	65.0 cd	30.0 d	20.0 d
2.0	1, 15, 30	85.0 a	87.5 ab	85.0 a*	62.5 d*	32.5 d	20.0 d
2.0	1, 30, 72	82.5 ab*	65.0 c	82.5 ab*	75.0 abc*	77.5 ab	70.0 b
2.0	1, 15, 30, 51	82.5 ab*	82.5 b	80.0 ab*	72.4 bcd*	72.5 abc	65.0 b
Check	-	00.0 e	00.0 g	00.0 f	00.0 h	00.0 e	00.0 e

[a] Rate of 2,4-D in 2.2 + 1.1 + .22 lb/gal (2,4-D + mecoprop + dicamba) formulation.

[b] All means within a column followed by the same letter do not differ significantly according to DMRT at .05 level of probability. Control rating system; 0 = no control, 100 = complete control. DAIT = day after initial treatment.

* Indicates unacceptable turf injury (25% or higher discoloration).

Table 3. Effect of 2,4-D + dicamba rate, application interval, and number of applications on Virginia buttonweed control at various time intervals after the initial treatment at Bel Air Country Club, Tupelo, MS. First application made July 18, 1983.

2,4-D[a] Rate	Days of application	Virginia Buttonweed Control[b], 9 DAIT	15 DAIT	30 DAIT	51 DAIT	72 days	86 DAIT
(lb/A)		(%)					
1.0	1	87.5 b*	87.5 b*	80.0 c	77.5 b	67.5 c	42.5 e
1.0	1, 15	85.0 bc*	82.5 b	87.5 b	72.5 c	65.0 c	57.5 d
1.0	1, 30	82.5 c*	85.0 b	100.0 a	100.0 a	92.5 a	72.5 c
1.0	1, 15, 30	85.0 bc*	77.5 b*	85.0 b	77.5 b	100.0 a	90.0 b
1.0	1, 30, 72	87.5 bc*	87.5 b*	100.0 a	100.0 a	100.0 a	100.0 a
1.0	1, 15, 30, 51	100.0 a*	100.0 a*	100.0 a*	100.0 a*	65.0 c	42.5 e
2.0	1, 15	100.0 a*	100.0 a*	100.0 a*	100.0 a*	80.0 b	75.0 c
2.0	1, 30	100.0 a*	100.0 a*	100.0 a*	100.0 a*	67.5 c*	70.0 c
4.0	1	100.0 a*	100.0 a*	100.0 a*	100.0 a	80.0 b	67.5 c
Check	-	00.0 d	00.0 c	00.0 d	00.0 d	00.0 d	00.0 f

[a] 2,4-D rate of the 1.25 + .12 lb/gal formulation.

[b] All means within a column followed by the same letter do not differ significantly according to DMRT .05 level of probability. Control rating system; 0 = no control, 100 = complete control. DAIT = day after initial treatment.

* Indicates unacceptable turf injury (25% or higher discoloration).

regrowth time following the final application. This was especially noticeable with the 1 lb + .1 (2,4-D + dicamba) rates of application. Regrowth occurred in four to six weeks following the final application with both biweekly or monthly applications.

When the rate was doubled (2 + .2 lb/acre, 2,4-D + dicamba) control of Virginia buttonweed increased; however, injury to the turf also increased significantly. The level of injury and length of time that injuy persisted make this rate unacceptable.

2,4-D/Dicamba Ratios

Results of studies involving a single application or monthly applications are recorded in Tables 4 and 5, respectively. Overall control in 1980 was better than in 1981. This was especially true when only one application was made. This difference most likely was attributable to higher temperatures and lower rainfall in 1981 than in 1980. These factors contributed to reduced regrowth potential of the Virginia buttonweed. Consequently, ratings were higher (better control) due to the lack of buttonweed regrowth.

The benefit of 2,4-D + dicamba was greater than that of either herbicide alone under the more adverse growing conditions in 1981. The higher dicamba rate (0.5 lb/acre) tended to be better than 2,4-D at 1 lb/acre.

Two applications gave better control than a single application, especially under the more adverse growing conditions. This was particularly noticeable 30 days after the last application.

The level of Virginia buttonweed control increased as the amount of dicamba in the mix (2,4-D + dicamba) was increased. Based on these studies, environmental conditions appeared to be an important factor in the control of buttonweed. The benefit of the addition of dicamba to 2,4-D was greater under the more adverse environmental conditions.

Table 4. Effect of a single application of selected ratios of 2,4-D:dicamba on Virginia buttonweed control at biweekly intervals following treatment. First application was July 18, 1980 (Columbus) or July 16, 1981 (Starkville).

		Virginia Buttonweed Control[a],							
		Starkville 1980[c]				Columbus 1981[d]			
Treatment	Rate	14 DAIT	28 DAIT	42 DAIT	56 DAIT	14 DAIT	28 DAIT	42 DAIT	57 DAIT
	(lb/A)	(%)							
2,4-D + dicamba	1.0 + .03	100.0 a*	80.0 ab	85.0 a	82.5 a	27.5 de	35.0 c	35.0 d	27.5 cd
2,4-D + dicamba	1.0 + .06	97.5 a*	90.0 a	82.5 a	90.0 ac	42.5 cd	82.5 ab	55.0 cd	55.0 a-c
2,4-D + dicamba	1.0 + .12	90.0 a*	70.0 ab	95.0 a	72.5 abc	65.0 abc	77.5 ab	52.5 cd	40.0 bc
2,4-D + dicamba	1.0 + .17	100.0 a*	77.5 ab	87.5 a	92.5 abc	77.5 abc	90.0 a	85.0 ab	67.5 ab
2,4-D + dicamba	1.0 + .25	100.0 a*	82.5 ab	85.0 a	97.5 ab	70.0 ab	82.5 ab	62.5 bcd	52.5 abc
2,4-D + dicamba	1.0 + .50	100.0 a	97.5 a	95.0 a	100.0 a	85.0 a	92.5 a	90.0 a	75.0 a
2,4-D	1.0	95.0 a	80.0 ab	47.5 b	65.0 c	30.0 de	62.5 b	47.5 cd	27.5 cd
dicamba	0.50	82.5 a*	65.0 ab	50.0 b	70.0 bc	50.0 bcd	82.5 ab	70.0 abc	62.5 ab
dicamba	0.25	85.0 a*	50.0 b	50.0 b	67.5 c	12.5 ef	62.5 b	52.5 cd	25.0 cd
Check	-	00.0 b	00.0 c	00.0 c	00.0 d	00.0 f	00.0 d	00.0 e	00.0 d

[a] All means within a column followed by the same letter do not differ at the 0.05 level according to DMRT. Control rating system; 0% = no control, 100% = complete control. DAIT = day after initial treatment.

* Indicates unacceptable turf injury (25% or higher discoloration).

Table 5. Effect of a monthly application of selected ratios of 2,4-D:dicamba on Virginia buttonweed at biweekly intervals following treatment. First applications were made July 18, 1980 (Columbus) or July 16, 1983 (Starkville). The second applications were made 28 days later.

		Virginia Buttonweed Control[a]							
		Starkville 1980				Columbus 1981			
Treatment	Rate	14 DAIT	28 DAIT	42 DAIT	56 DAIT	14 DAIT	28 DAIT	42 DAIT	57 DAIT
	(lb/A)	(%)							
2,4-D + dicamba	1.0 + .03	98.5 ab*	80.0 ab	90.0 a*	97.5 a	32.5 de	42.5 c	82.5 a	75.0 a
2,4-D + dicamba	1.0 + .06	95.0 ab*	80.0 ab	100.0 a*	100.0 a*	55.0 b-d	80.0 ab	92.5 a	85.0 a
2,4-D + dicamba	1.0 + .12	75.0 b	92.5 a	100.0 a*	100.0 a	67.5 ab	87.5 a	97.5 a	87.5 a
2,4-D + dicamba	1.0 + .17	100.0 a	85.0ab*	100.0 a*	100.0 a*	67.5 ab	80.0 ab	95.0 a*	70.0 a
2,4-D + dicamba	1.0 + .25	100.0 a*	90.0 a	100.0 a*	100.0 a	67.5 ab	85.0 a	82.5 a	92.5 a
2,4-D + dicamba	1.0 + .50	97.5 ab*	92.5 a	100.0 a*	100.0 a*	80.0 a	95.0 a	100.0 a*	92.5 a
2,4-D	1.0	95.0 ab	90.0 a	100.0 a*	100.0 a	42.5 cd	82.5 a	97.5 a	87.5 a
dicamba	0.50	77.5 ab*	67.5 ab	85.0 a	97.5 a	47.5 bcd	75.0ab	100.0 a	72.5 a
dicamba	0.25	85.0 ab	52.5 b	80.0 a	85.0 a*	15.0 ef	55.0 bc	95.0 a	82.5 a
Check	-	00.0 c	00.0 c	00.0 b	00.0 b	00.0 f	00.0 d	00.0 b	00.0 b

[a] All means within a column followed by the same letter do not differ at the 0.05 level according to DMRT. Control rating system: 0% = no control, 100% = complete control. DAIT = day after initial treatment.

* Indicates day of additional application(s).

Summary Comments

The best herbicide or herbicide combination of the materials evaluated for Virginia buttonweed control was 2,4-D + dicamba. Changing the 2,4-D/dicamba ratio resulted in a slight change in the level of control. Addition of dicamba above the normal 10:1 ratio does not appear warranted unless adverse environmental conditions exist.

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Red Rice Control with Postemergence Herbicides

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Editor's Note

The 3m Company has changed Vistar® to Embark® since this publication was prepared for printing.

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Red Rice Control with Postemergence Herbicides

INTRODUCTION

Red rice is a persistent and troublesome weed in rice and soybeans grown in Arkansas, Louisiana, Mississippi, and Texas. Reports (4,12) indicate that red rice was present in cultivated rice as early as 1846, long before rice was cultivated on a commercial scale in these states (3). Red rice generally is classed as strawhull and blackhull biotypes (10).

Numerous herbicides have been evaluated for control of red rice in water-seeded domestic rice, but no herbicide has given better control in field studies than has molinate (Ordram®) (9). Most red rice control programs rely on chemical and cultural control techniques in rotational cropping systems. The three-year rotation includes two years of soybeans followed by rice the third year or one year of grain sorghum and one year of soybeans followed by rice (10). Soybean-rice rotations are common in Mississippi, where strawhull red rice is the principal red rice biotype. During the soybean years of this rotation, alachlor (Lasso®), metolachlor (Dual®), trifluralin (Treflan®), fluchloralin (Basalin®) and pendimethalin (Prowl®) alone or with metribuzin (Sencor® or Lexone®) are used frequently to control red rice. These treatments may be followed by directed postemergence sprays of linuron (Lorox®), paraquat or metribuzin after soybeans are at least 8 inches tall or by bentazon (Basagran®) + mefluidide (Vistar®) when soybeans are in the one-trifoliolate leaf stage (1).

Herbicides that can be applied postemergence to give selective control of red rice irrespective of soybean growth stage are desirable in a rotational program. The new generation of selective grass herbicides may provide this capability. These compounds have been reported to control annual grasses (8), johnsongrass (6, 7), quackgrass (5) and common bermudagrass (2) in soybeans and cotton. The objective of this research was to determine the phytotoxicity (% injury) of five herbicide treatments applied postemergence at two growth stages of strawhull and blackhull red rice, Starbonnet domestic rice and Centennial soybeans. Starbonnet was included as a representative domestic rice cultivar to determine which, if any, of the five herbicides are sufficiently selective to permit use for control of red rice in domestic rice.

MATERIALS AND METHODS

Experiments with herbicides applied during the (a) one- to two-leaf stage of rice and unifoliolate stage of soybeans and (b) five- to six-leaf stage of rice and trifoliolate stage of soybeans were conducted on a Leeper silty clay loam on the plant science farm at Mississippi State, Mississippi in 1981 and were repeated in 1982 on the same soil type, but on a different site in the same field. Strawhull red rice, blackhull red rice, Starbonnet rice or Centennial soybeans each were planted 1 inch deep in rows spaced 24 inches apart.

In the first experiment, sethoxydim (Poast®), DPX Y6202 (Assure®), haloxyfop (Verdict®), fluazifop (Fusilade®) and Vistar + Basagran were applied postemergence to one- to two-leaf rice and unifoliolate soybeans. Rates applied are listed in Table 1.

In the second experiment, the above treatments were applied postemergence to five- to six-leaf rice and three trifoliolate soybeans and repeated. Rates applied are listed in Table 2.

A CO_2-pressurized backpack sprayer was used to apply the herbicides in water at 20 gpa to a 40-inch spray swath. Plot size was four rows eight ft long. Nonoxynol (9 to 10 POE) at 0.25% (v/v) was added to each treatment in 1981 and to Vistar + Basagran in 1982. Except for Vistar + Basagran, 1.25% (v/v) oxysorbic (polyoxyethylene sorbitan fatty acid ester) in mineral oil [(17):83% w/w] was added to each treatment in 1982.

The three rice biotypes, the soybeans, and the five herbicide treatments (along with their respective untreated checks) were arranged factorially as a 3 x 5 experiment in a randomized complete block design with four replications. All plots were hoed and hand-weeded on the day of herbicide application each year. Planting, treatment and rain-

fall data are listed in Table 3.

Injury to rice and soybeans resulting from the herbicide treatments was rated visually on a scale of 0 (no apparent effect) to 100% (death) as compared to their respective untreated check. Ratings were recorded 11 and 7 days after the first application and 17 and 22 days after the second application to one- to two-leaf rice and unifoliate soybeans in 1981 and 1982, respectively. On five- to six-leaf rice and three trifoliolate soybeans, ratings were recorded 7 and 8 days after the first application and 24 and 13 days after the second application in 1981 and 1982, respectively. Specific rating dates are listed in Table 3.

Each rating for each experiment in 1981 and 1982 was subjected to analysis of variance. Means were compared by the Waller-Duncan's Bayesian *k*-ratio (*k* = 100 *t* test (11)

RESULTS AND DISCUSSION

Soybean injury by the herbicides evaluated did not exceed 20%, and these symptoms were no longer visible four weeks after treatment evaluation. The most effective single treatment for control of one- to two-leaf rice in soybeans was Vistar + Basagran at 0.125 + 0.75 lb ai/A except for control of Starbonnet with Assure at 0.25 a.i./A in 1981 (Table 1). However, when soybeans and red rice emerge simultaneously, as they did in this study, this herbicide mixture should not be used because the current label specifies application of Vistar + Basagran only after the first full trifoliolate leaf on the soybean plant has expanded (1). The soybeans in these studies had only the unifoliolate leaves at the time of the first application.

Given the current label restriction on Vistar + Basagran and the relatively low level of injury to one-

Table 1. Percent injury to three rice biotypes sprayed at the one- to two-leaf growth stage with five herbicide treatments in 1981.[1/]

Treatment		Rice type and application						Means[4/]	
		Strawhull		Blackhull		Starbonnet			
Herbicide(s)	Rate (lb/A)	1st[2/]	2nd[3/]	1st	2nd	1st	2nd	1st	2nd
		(Percent Injury)							
Poast®	0.50	51 d-g	97	46 d-h	98	61 b-e	96	53 B	97 A
Assure®	0.25	58 c-e	99	61 b-e	98	88 ab	99	69 B	99 A
Verdict®	0.25	40 d-i	96	30 f-d	97	54 c-f	98	41 B	97 A
Fusilade®	0.25	16 i	90	26 g-i	81	35 e-i	82	26 C	84 B
Vistar® + Basagran®	0.125 + 0.75	94 a	96	81 a-c	90	67 a-d	91	81 A	92 AB
Means		52	96	49	93	61	93		

1/ Values within rows and columns for each application across rice types followed by the same lower case letter(s) do not differ according to the Waller-Duncan's Bayesian k-ratio (k = 100) t test. Values not followed by letters do not differ.

2/ Rated 11 days after treatment on August 6, 1981.

3/ Rated 17 days after treatment on August 21, 1981.

4/ Herbicide means within columns for each appliction followed by the same upper case letter(s) do not differ.

Table 2. Percent injury to three rice biotypes sprayed at the five- to six-leaf growth stage with five herbicide treatments in 1981.[1/]

Treatment		Rice type and application							
		Strawhull		Blackhull		Starbonnet		Means[4/]	
Herbicide(s)	Rate (lb/A)	1st[2/]	2nd[3/]	1st	2nd	1st	2nd	1st	2nd
		(Percent Injury)							
Poast®	1.0	92	98 a	82	95 a	83	96 a	86 AB	96 A
Assure®	0.5	93	99 a	91	99 a	94	99 a	93 A	99 A
Verdict®	0.5	80	96 a	81	96 a	74	96 a	78 B	96 A
Fusilade®	0.5	53	90 ab	45	86 ab	49	91 ab	49 C	89 B
Vistar® + Basagran®	0.125 + 0.75	88	94 a	84	76 b	94	98 a	89 A	89 B
Means[4/]		81	95	77	90	79	96		

1/ Values within rows and columns for each application across rice types followed by the same lower case letter(s) do not differ according to the Waller-Duncan's Bayesian k-ratio (k = 100) t test. Means not followed by letters do not differ.

2/ Rated 7 days after treatment on August 21, 1981.

3/ Rated 24 days after treatment on August 28, 1981.

4/ Herbicide means within columns for each application followed by the same upper case letter(s) do not differ.

Table 3. Planting, treatment, rating, and rainfall parameters for Experiments 1 and 2 in 1981 and 1982.

Year	Date planted	Treatment No.	Treatment Date	$\bar{X}$ Plant height at 1st trt[1/] SHR	BHR	SBD	Soybean growth stage Height	Leaves	Injury[2/] (control) ratings No.	Date	Rainfall Quantity	Time after application
				(cm)				(No.)			(cm)	(h)
Experiment 1 (1- to 2-leaf rice)												
1981	July 27	1	Aug. 6	6	11	5	9	1[3/]	1	Aug. 17	1.30	24
		2	Aug. 21						2	Aug. 28	0.76	2
1982	June 8	1	June 18	6	8	5	8	1[3/]	1	June 25	0.00	264
		2	June 25						2	July 8	0.00	72
Experiment 2 (5- to 6-leaf rice)												
1981	July 27	1	Aug. 21	15	18	15	15	3[4/]	1	Aug. 28	0.76	2
		2	Aug. 28						2	Sept. 7	0.00	96
1982	June 8	1	July 8	13	13	13	18	3[4/]	1	July 16	2.30	6
		2	July 16						2	July 23	0.00	72

1/ SHR = Strawhull red rice; BHR = Blackhull red rice; SBD = Starbonnet domestic rice.

2/ Rating 1 = control (injury) after treatment; Rating 2 after treatment 2.

3/ Unifoliolate.

4/ Trifoliolate.

to two-leaf red rice from one application of the other herbicides, control of rice at an average level of 90% or more required two applications of Poast at 0.50 lb/A or Assure and Verdict at 0.25 lb/A (Tables 1 and 4).

Assure was the only treatment that resulted in an average of 90% (actually more than 90%) red rice injury 7 and 8 DAT in 1981 and 1982 when applied once to five- to six-leaf red rice seedlings (Tables 2 and 5). Mosier et al (8) reported that four-to six-leaf red rice was not controlled ($\geq$ 75%) by a single application of Fusilade at rates up to 0.60 lb/A while Verdict at 0.50 lb/A and Poast at 0.60 lb/A were effective. Again, the time between treatment application and injury evaluation may have been too short in these studies. A single application of Assure was not significantly more injurious to rice than were Poast or Vistar + Basagran in 1981.

Averaged across rice biotypes and years, all treatments except Fusilade resulted in 85 to 99% rice injury when applied twice to five- to six-leaf rice. Fusilade resulted in an average injury level of 73%, which was nearly the same average injury level (75%) resulting from two applications to one- to two-leaf rice. Soybean growth stage probably would not be a limiting factor in applying Vistar + Basagran to five- to six-leaf red rice as the soybean plants had three trifoliolate leaves when applied in these studies.

Mean injury to rice biotypes averaged over herbicides differed in 1982 after one application. The herbicides resulted in significantly less injury to 5- to 6-leaf Starbonnet than to strawhull red rice but not to blackhull (Table 5), but, at the one- to two-leaf stage, strawhull red rice was injured less than blackhull or Starbonnet (Table 4).

A significant herbicide by rice biotype interaction occurred in 1981 after two herbicide applications to five- to six-leaf red rice (Table 2) and after one application to one- to two-leaf rice in 1981 (Table 1). No logical explanation is offered for these responses, other than some unmeasured environmental effect peculiar to 1981, as neither interaction repeated itself in 1982. It is clear, however, that none of the treatments were safe enough to Starbonnet to permit their use to control red rice in Starbonnet plantings.

Table 4. Percent injury to three rice biotypes sprayed at the one- to two-leaf growth stage with five herbicide treatments in 1982.1/

Treatment		Rice type and application						Means	
		Strawhull		Blackhull		Starbonnet			
Herbicide(s)	Rate (lb/A)	1st2/	2nd3/	1st	2nd	1st	2nd	1st	2nd
		(Percent Injury)							
Poast®	0.50	24	96	31	95	35	77	30 C	89 A
Assure®	0.25	50	99	63	99	68	99	60 B	99 A
Verdict®	0.25	49	99	53	99	63	97	55 B	98 A
Fusilade®	0.25	36	56	40	73	55	73	44 B	62 B
Vistar® + Basagran®	0.125 + 0.75	89	99	88	98	85	97	87 A	98 A
Means		50 B	90	58 A	93	63 A	89		

1/ Herbicide means within columns and rice type means within rows for each application followed by the same upper case letter(s) do not differ according to the Waller-Duncan's Bayesian k-ratio (k = 100) t test. Means not followed by letters do not differ.

2/ Rated 7 days after treatment on June 18, 1982.

3/ Rated 22 days after treatment on June 25, 1982.

Table 5. Percent injury to three rice biotypes sprayed at the five- to six-leaf growth stage with five herbicide treatments in 1982.1/

Treatment		Rice type and application							
		Strawhull		Blackhull		Starbonnet		Means	
Herbicide(s)	Rate (lb/A)	1st2/	2nd3/	1st	2nd	1st	2nd	1st	2nd
		(Percent Injury)							
Poast®	1.0	56	76	51	73	46	73	51 B	74 C
Assure®	0.5	97	99	92	99	93	99	94 A	99 A
Verdict®	0.5	76	92	66	99	54	85	65 B	92 AB
Fusilade®	0.5	39	63	35	53	30	55	35 C	57 D
Vistar® + Basagran®	0.125 + 0.75	71	91	53	86	49	80	58 B	86 BC
Means		68 A	84	59 AB	82	54 B	78		

1/ Herbicide means within columns and rice type means within rows for each application followed by the same upper case letter(s) do not differ according to the Waller-Duncan's Bayesian k-ratio (k = 100) t test. Means not followed by letters do not differ.

2/ Rated 8 days after treatment on July 8, 1982.

3/ Rated 13 days after treatment on July 16, 1982.

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July 1985

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Mississippi State University

Combining Tarnished Plant Bug Resistance with Frego Bract

USDA, ARS
in cooperation with

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MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
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Combining Tarnished Plant Bug Resistance with Frego Bract

Abstract

Three crosses, (A) La Frego 2 X Timok 811, (B) Timok Frego from cross A X D7146N and (C) the F_1 of cross B X D7146N, were made and several progeny in F_3 through F_5 of each cross were evaluated in field plots with a high population of tarnished plant bugs, *Lygus lineolaris* (Palisot de Beauvois), in 1978, 1979 or 1980. We tested the hypothesis that resistance to tarnished plant bugs by frego strains can be improved by combining earliness and genetic resistance of Timok 811 with the nectariless trait of D7146N. We found that this hypothesis was valid because we were able to develop frego strains with tarnished plant bug resistance and earliness comparable with that of Timok 811, and yield, boll size and lint percent comparable with that of La Frego 2 and D7146N. Results of this study also indicated that Timok 811 is a useful genetic source of resistance to tarnished plant bug.

The frego bract trait in cotton, *Gossypium hirsutum* L., produces long, narrow and twisted bracts that tend to curl outward, leaving the flower bud and subsequent boll more exposed than do the flat, triangular bracts of normal cotton. This trait was found to be associated with resistance to the boll weevil by Jenkins and Parrott (1971) and resistance to boll rot by Jones and Andries (1969), and has been shown by Parrott et al. (1973) to enhance insecticidal coverage. A major limitation of this trait is its extreme sensitivity to the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (Lincoln et al., 1971), an early season insect and economic pest on cotton in much of the Southeastern cotton belt. Damage results in dead terminals, abscission of squares and altered forms of vegetative and fruiting growth patterns that usually are associated with yield losses and delayed maturity.

Variable sensitivity of frego-bract cotton lines to the tarnished plant bug has been reported by Naresh (1977). He investigated frego bract in eight genetic backgrounds grown with high levels of plant bugs. The frego trait in 'Auburn 56', Arkansas Stormproof, 'Acala 1571D' and TX-ORH-37 produced higher yields than did frego of other backgrounds.

Several traits of normal-bract cotton and the Timok 811 source of resistance have been identified as providing moderate resistance to this early season pest. The most important of these are the nectariless trait (Meredith et al., 1973 and Schuster and Maxwell, 1974) and the Timok 811 source of resistance (Jenkins and Parrott, 1976; Lambert, 1977 and Jenkins et al., 1977). The purpose of this study was to determine if resistance to tarnished plant bug by frego strains can be improved by combining earliness and the genetic resistance of Timok 811 with the nectariless trait of D7146N.

Materials and Methods

We used three sources of genetic material. Timok 811 (accession 1082 in the Regional Collection) has a low lint percent (23.4) and yield (Anonymous, 1974); however, it is moderately resistant to tarnished plant bugs *Lygus lineolaris* (Palisot de Beauvois) and very early. La Frego 2, a strain from Louisiana, has the frego-bract trait and has high lint percent and boll size. In the absence of tarnished plant bugs its yield is medium. It is highly susceptible to tarnished plant bugs as are most frego strains. D7146N, a nectariless strain of the Deltapine type, has high yield, average boll size and high lint percent. Nectariless gives it moderate resistance to tarnished plant bugs.

We used three crosses in this study---(A) La Frego 2 X Timok 811, (B) Timok Frego from cross A X D7146N and (C) the F_1 of cross B X D7146N. Several progeny from cross A were evaluated in F_3, F_4 and F_5 in 1978, 1979 and 1980, respectively, by growing them in field plots with large populations of tarnished plant bugs. Progeny from crosses B and C were grown in 1979 and 1980. We tested the hypothesis that resistance to tarnished plant bugs by frego strains can be improved by combining earliness and resistance from Timok 811 with nectariless from D7146N.

All plots were grown at the Plant Science Research Center, Mississippi State University on a Leeper silty clay loam, fine montmorillionitic, nonacid, thermic, chromondertic Haplaquept, 0-2% slope. Field plots were two rows spaced 1 meter and were 11.6, 6.1 and 8.5 meters long in the three years, respectively. Four rows of cotton were bordered by two rows of mustard, *Brassica juncea* (L.) Czern and Coss. The mustard attracted tarnished plant bugs and provided a nurse crop to build up their numbers (Laster and Meredith, 1974).

Plots were planted May 17, 16 and April 30 in 1978, 1979 and 1980. Insecticide programs on all plots were initiated August 10, 1 and July 2 in the three years. This allowed plant

bugs to damage the plants early but controlled them and other pests later in the season.

Boll samples were hand harvested each year to evaluate lint percent and boll size. Plots were mechanically harvested on September 22 and October 12 in 1978, on October 10 and 31 in 1979 and on September 18 and October 14 in 1980. Earliness was measured as the percentage of total yield at first harvest each year.

These techniques measured tarnished plant bug resistance and the ability to yield under high numbers of plant bugs during the early part of the fruiting season.

Results and Discussion

We report data only from the highest-yielding and earliest selections after three years of testing five frego selections from cross A. We generally were successful in improving lint percent, boll size and earliness over that of the Timok 811 parent. Stoneville 817 frego was as susceptible as La Frego 2, but none of the five frego lines yielded as well as did Stoneville 817 frego when plant bugs were present (Table 1). We used this line because it was the highest-yielding frego line in our program at the time. The extreme earliness and low lint percent of the Timok 811 parent apparently was troublesome in this cross.

We evaluated several nectariless and frego nectariless progeny from cross B expecting them to perform better agronomically than does cross A. Data from five nectariless selections and five frego nectariless selections with the best agronomic performance and resistance are presented in Table 2. Yield of three of these four nectariless strains was similar to that of D7146N in 1979 and 1980. All were significantly earlier than D7146N. The five frego nectariless strains were significantly earlier than Stoneville 817 frego, but only one was as early as D7146N. Selection 22 yielded as well as D7146N and far better than Stoneville 817 frego when grown with high numbers of plant bugs. Performance of this frego nectariless strain indicated that we were successful in combining frego with nectariless to produce a strain that was as early and productive, and as resistant to plant bugs as the normal-bract strain D7146N.

The performance of several backcross progeny from cross C was evaluated in 1979 and 1980. Data from five nectariless selections with the best agronomic performance and resistance are presented in Table 3. Lint percentage and boll weights were not different from those of D7146N. Yield of each of the selections was comparable to that of D7146N in 1979, but only 12NE yielded as well as did D7146N in 1980. All five strains were earlier than D7146N.

Results of this study indicate that our hypothesis was valid, because we were able to develop frego strains with improved tarnished plant bug resistance by combining earliness, genetic resistance to the plant bug and nectariless into such strains.

These data also indicate that frego strains can be used in plant bug areas if we combine frego with earliness and plant bug resistance from a source such as Timok 811. This would allow us to use the advantages of frego, such as resistance to boll weevil, *Anthonomus grandis* (Boheman) (Jenkins and Parrott, 1971), resistance to boll rots (Jones and Andries, 1969) and improved insecticide coverage (Parrott et al., 1973).

Table 1. Agronomic performance of selections from cross A (Timok 811 X La Fg 2) when grown with high populations of tarnished plant bugs.

		1978			1979			1980				
Selection	Cross	1st pick	Total pick	% 1st pick	1st pick	Total pick	% 1st pick	1st pick	Total pick	% 1st pick	Lint %	Boll size
		kg/ha										g
1 FG	A	488	755	65	426	500	85	781	876	89	37.6	4.75
4 FG	A	505	723	68	408	498	82	717	854	84	37.4	4.75
7 FG	A	430	738	58	411	514	80	787	915	86	37.6	4.76
8 FG	A	415	701	60	444	529	84	720	842	86	37.9	4.50
10 FG	A	467	674	67	421	511	83	659	786	84	36.6	4.72
ST817FG	A	466	809	55	242	366	66	697	1046	67	41.3	5.09
LSD .05	A	153	169	10	72	76	7	127	108	7	1.6	0.29

Table 2. Agronomic performance of selections from cross (B Timok 811 FG X D7146) when grown with high populations of tarnished plant bugs.

		1979			1980				
Selection	Cross	1st pick	Total pick	% 1st pick	1st pick	Total pick	% 1st pick	Lint %	Boll size
		kg/ha			kg/ha				g
2 NE	B	477	672	71	906	1065	85	36.3	4.45
3 NE	B	323	650	50	918	977	94	38.7	4.24
4 NE	B	407	617	66	894	971	92	37.1	5.03
7 NE	B	462	599	77	831	890	93	37.3	4.53
8 NE	B	524	657	80	899	965	89	37.4	4.47
11 FGNE	B	195	373	52	719	889	81	37.9	4.94
12 FGNE	B	187	357	52	699	891	77	38.1	5.05
15 FGNE	B	345	500	69	781	859	91	35.8	5.01
21 FGNE	B	235	368	65	745	954	78	38.9	4.93
22 FGNE	B	259	445	58	900	1046	86	38.1	5.41
ST817FG	B	130	297	44	697	1046	67	41.3	5.09
D7146N	B	267	543	49	907	1002	91	38.6	5.38
LSD .05	B	85	118	8	127	108	7	1.6	0.29
D7146N	B*				961	1108	87	36.8	5.38
LSD .05	B*				112	118	2	1.2	0.35

*Comparisons with NE lines in 1980.

Table 3. Agronomic performance of selections from cross C [(Timok 811 FG X D7146) x D7146] when grown with high populations of tarnished plant bugs.

		1979			1980				
Selection	Cross	1st pick	Total pick	% 1st pick	1st pick	Total pick	% 1st pick	Lint %	Boll size
		kg/ha			kg/ha				g
7 NE	C	528	734	72	813	886	92	34.8	5.11
9 NE	C	545	753	72	886	958	93	36.5	4.77
10 NE	C	371	527	70	864	943	92	35.6	5.09
12 NE	C	512	744	69	983	1069	92	35.8	5.15
15 NE	C	534	768	70	842	938	90	35.6	4.80
D7146N	C	299	664	45	961	1108	87	36.8	5.38
LSD .05	C	NS	NS	1	112	118	2	1.2	0.35

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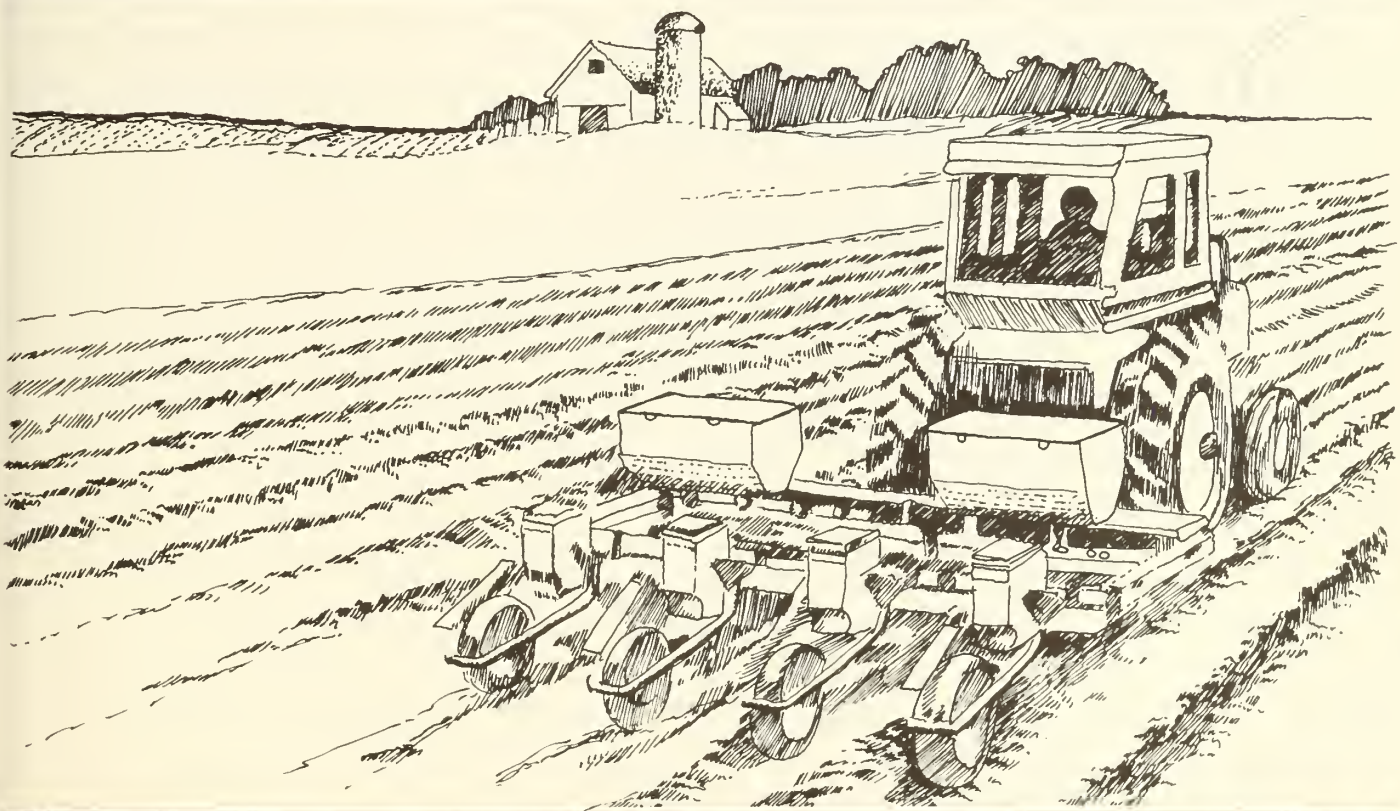
Bulletin 940 July 1985

Fuel-Consumption and Fuel-Cost Prediction Model

for Agricultural Crop Production

For Apple II Plus, IBM PC and Radio Shack TRS-80



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FUEL-CONSUMPTION AND FUEL-COST PREDICTION MODEL FOR AGRICULTURAL CROP PRODUCTION for APPLE II PLUS, IBM PC and RADIO SHACK TRS-80*

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and
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Agricultural and Biological Engineering Department

*Anyone interested in using this program may obtain a copy of the disk for their computer by sending a request, along with the appropriate blank diskette(s) to

Dr. Fred L. Shuman, Jr.
Agricultural and Biological Engineering Department
P.O. Box 5465
Mississippi State, MS 39762

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FUEL-CONSUMPTION AND FUEL-COST PREDICTION MODEL FOR AGRICULTURAL CROP PRODUCTION for APPLE II PLUS, IBM PC and RADIO SHACK TRS-80

The primary concern of farmers when acquiring equipment in the past was whether the equipment could do the job and not how efficiently the job could be done. This lack of concern for efficiency has left the agricultural industry with little practical information to draw from now that the need for minimizing fuel consumption has become increasingly apparent.

Our review of the information available (1,2,4,5,6) revealed no convenient method for accurately predicting fuel requirements for crop production. A method of calculation tailored to the needs of individual farmers operating under unique conditions is needed. Therefore, efforts were initiated in the Agricultural and Biological Engineering Department to develop processes for calculating the consumption and costs of fuel for crop production.

We developed a computer model that provides practical information for use by farmers in selecting the proper equipment, estimating operating costs and following least-cost procedures for soybean production. The model can be used for making the same estimates for production of other crops if the implements selected are from those listed in the computer program.

The initial model was based on a number of typical sizes of John Deere tractors that were then in use. The model now includes other tractors, and the tractors for which the model will predict performance are contained in the file "Tractors" on the computer disk that contains the program.

Tractor information is taken from Nebraska Tractor Test data (3). The model computes implement draft, drawbar power, axle power, maximum available power-take-off power, percent load, percent slip, tractive efficiency, desired no-load forward speed, fuel efficiency for each operation, fuel consumption per unit of land area, fuel cost per unit of land area, total fuel consumed, total fuel cost and overall fuel efficiency.

One of our major concerns in developing the initial model was the fact that most previous attempts at predicting energy input were based on average tractor and implement sizes, or on the assumption that a tractor of any size would be used to pull an implement of only one size. Our model has the flexibility to include tractors of any size, implements of any size and combinations of tractors and implements of different sizes. Also, other methods assume "usual conventional input practices", but our model permits the user to adapt operations to unique situations (e.g., different soil types or conditions).

The major purpose of our model is to present options to help farmers reduce their costs of production by minimizing the amount of fuel used. However, it has additional applications; e.g., the development of estimates of production costs to be used when applying for production credit.

PROGRAM DEVELOPMENT

This program was developed initially for a microcomputer system (Tektronix 4051 microcomputer terminal, Tektronix 4907 disk drive and Digitax Dekwriter III printer). It was obvious at the outset that a limited number of Mississippi farmers would be expected to own or have access to this particular system. The Tektronix equipment was available during the development phase of the model; therefore, it was used as the primary system. However, farmers do use a variety of computer systems, so, to maximize the use of the computer model, it has been programmed for the Apple II Plus, IBM Personal Computer, Radio Shack TRS-80 Model III, Tektronix 4051 and UNIVAC 1100/80.

Some close comparisons of model results have been made with actual costs of soybean production, but the information obtained through use of the computer model is dependent on choices of variables made by the user. Therefore, the values obtained are to be considered only as approximations to the quantities and costs of fuel used in actual operations.

Specific instructions for running the program on the Apple II Plus, the IBM PC and the Radio Shack TRS-80 microcomputers are presented in the following sections.

Fuel-Consumption and Fuel-Cost Predicti Model for Agricultural Crop Production

APPLE II Version

NOTE: The operating procedure was developed for the use of the Apple II Microcomputer with a sing drive system and a printer. The printer must be connected to slot number 1 of the computer.

OPERATING PROCEDURE

The Fuel-Consumption and Fuel-Cost Prediction Model for Agricultural Crop Production is stored on a 5 1/4-inch floppy diskette. A DOS 3.3 System Master diskette is required for use of the program diskette. The model was developed for the convenience of the inexperienced user and may be run by performing the following steps:

1. Power up the disk drive unit, monitor and printer.
2. Place the flexible disk containing the DOS 3.3 System Master in the Disk Drive.
3. Enter PR#6 on the keyboard. This stores the DOS in High Memory.
4. Remove the System Master diskette and replace it with the program diskette.
5. Enter LOAD PROGRAM
6. Enter RUN

The program is now ready to run. The fuel-consumption and fuel-cost model is a user-directed type that is "menu" oriented, in that program flow is controlled by selections from a list that is printed out upon completion of each job. Initially, the model also provided an automatic or "hands-off" version that required very little interaction from the user. However, this version, though easier to use, proved to be too restrictive and was eliminated.

PROGRAM EXECUTION

Program execution begins when the user enters RUN on the keyboard. The title of the model is displayed at the top of the screen, and the user must answer several questions, as they are asked, by entering a make and model of tractor; the number of acres to be worked and the price of diesel fuel or the price of gasoline (or both). NOTE: (A decimal number in the form X.XX i entered, but no dollar sign is used.)

The present method of running the fuel-consumptio and fuel-cost model is the "User-Interactive" mode. Thi process allows the user to control the program flow Fuel consumption will be predicted only for the opera tions desired. To run the program in this mode, the use must enter RUN on the keyboard. This action will cause all of the variables to be initialized and will allow program execution to begin.

Several options are given in the user-interactive mode that allow the user either to choose input data from a range displayed for each implement or to use pre-programmed values, which are average values of the range for the implement.

Next, the user chooses the type of tractor selected to perform the operations. The tractor test data, such as maximum horsepower, static rear-axle force and drawbar height are supplied by the user (from the Nebraska Test data on the disk) as needed during the interactive session.

After the options for using the model have been given, instructions for running the program are displayed on the screen. When the list of possible operations is displayed, the user must enter the number corresponding to the desired job. When a particular operation is completed, the list of possible operations (shown on page 5) is again displayed, allowing the user to make another choice. This process will continue until Item number 12 (STOP PROGRAM EXECUTION) is chosen from the list.

The user is allowed to choose the operations to be performed and the number of times for each. Comparisons may be made between several runs of a single operation; e.g., if Item number 2, DISK HARROW, were chosen, the computer would display OPERATION: DISK HARROW on the screen and then ask for the

umber of times the operation is to be performed. All uestions are to be answered by the user as they are sked. When the user enters the Nebraska tractor test ata the program will give the option of using the same actor for each run, or using different tractors. The actor name is entered along with the type of fuel, aximum horsepower, the static rear axle force, rawbar height, wheelbase, horizontal distance to the enter of gravity and vertical distance to the center of ravity.

Next, a soil condition is chosen for each run, and the peed and implement widths are selected. After these alues are entered, the computer asks if a hard copy f the results is desired. When the user selects the appropriate option, the screen is cleared, tractor performance and fuel consumption data are displayed on the creen and are printed out for each run.

The questions encountered for all of the operations re similar, except for the combine operation. If this em is chosen from the list, the computer will give the ser the option of choosing the approximate percent f maximum power required to perform the job, or of sing a pre-programmed value of 85%. Depending on eld conditions, this value could vary greatly between uns. If the user enters N, the value of 85% is used.

Next, the user is prompted to enter the number of uns, the speed for each run, header width, maximum orsepower and fuel type. Machine performance and uel consumption data then are displayed on the screen nd printed by the printer.

All fuel consumption data obtained from the individual operations are saved in memory to be displayed in the summary, if desired, unless the user uns through an operation more than once (by choosing that operation from the list of possible operations more than once). Then only the data for the final run will be saved for the summary.

To view all previous fuel requirements for the operations (except as noted above), the user must choose Item number 11 (SUMMARY FOR ALL OPERATIONS). NOTE: The summary is not printed by the printer, because the same information was printed as it was being calculated for each opertion). The data for each operation are displayed.

Data Display Example

Chisel Plow No. 1
Fuel Consumed/Unit Area..1.90 Gal/Ac (17.76 L/Ha)
Fuel Cost/Unit Area $2.37/AC ($5.86/HA)
Fuel Needed. .....379.65 Gal (1437 L)
Cost of Operation. $474.56

To view total fuel consumption and fuel cost of all operations, Item number 10 (TOTAL OF ALL OPERATIONS) must be chosen from the list. The following is an example of the type of data displayed. A hard copy of the total will be generated as well.

Total for Diesel for all Operations*

Total Fuel/Unit Area. ....1.90 GAL/A (17.76 L/HA)
Total Fuel Cost/Unit Area. $2.37/A ($5.86/HA)
Total Fuel Required. .....379.65 GAL (1437 L)
Total Fuel Cost. $474.56

Where
GAL = U. S. Gallons
A = Acre
L = Liters
HA = Hectare

If desired, the user may change the input parameters (such as, the tractor and the implement width) and may rerun the program to make comparisons for purposes of determining the least-cost combination for accomplishing the desired operations.

When the work is completed, remove the disk and turn off the system.

**These data are totals for the one chisel plow operation shown above.*

Fuel-Consumption and Fuel-Cost Predictio Model for Agricultural Crop Production

IBM Version

NOTE: The operating procedure was developed for use of the IBM Personal Computer and IBM or EPSON printer. 62 k bytes of memory are required.

OPERATING PROCEDURE

The Fuel-Consumption and Fuel-Cost Prediction Model for Agricultural Crop Production is stored on a 5 1/4-inch floppy diskette. The model was developed for the convenience of the inexperienced user and may be run by performing the following steps:

1. Place the flexible disk in the Disk Drive.
2. Power up by turning on the disk drive unit, monitor and printer.
3. Enter date and time.
4. Enter BASIC
5. Press the function key [F3], then enter CPFUEL
6. Press [F2].

The program is now ready to run. The IBM versio of the fuel-consumption and fuel-cost model also is user-interactive type that is "menu" oriented, in tha program flow is controlled by selections from a list tha is printed out upon completion of each job.

Program execution is virtually the same as for th Apple II microcomputer (as given in that section unde the heading "Program Execution"). To run the progran the user can enter RUN or press the [F2] key.

When the work is completed, remove the disk an turn off the system.

TRS-80 Version

NOTE: The operating procedure was developed for the use of the Radio Shack TRS-80 Model III Microcomputer.

OPERATING PROCEDURE

The Fuel-Consumption and Fuel-Cost Prediction Model for Agricultural Crop Production is stored on a 5 1/4-inch floppy diskette. The model was developed for the convenience of the inexperienced user and may be run by performing the following steps:

1. Power up by turning on the microcomputer and printer.
2. Place the flexible disk in the Disk Drive.
3. Enter the date and time.
4. Enter BASIC
5. Enter LOAD"CPFUEL"
6. Enter RUN

The program is now ready to run. The fuel-consumption and fuel-cost model also is a user-interactive type that is "menu" oriented, in that program flow is controlled by selections from a list that is printed out upon completion of each job.

Program execution is the same as for the Apple II microcomputer (as given in that section under the heading "Program Execution").

When the work is completed, remove the disk and turn off the system.

LIST OF POSSIBLE OPERATIONS

NUMBER	NAME	FUNCTION
1.	CHISEL PLOW	The model prompts the user to input necessary data for chisel plow operation.
2.	DISK HARROW	The model prompts the user to input data for the disk harrow operation.
3.	DISK AND INCORP	Prompts the user to input data for the disk and incorporate operation.
4.	FIELD CULTIVATE	Prompts the user to input data for the field cultivate operation.
5.	HARROW	Prompts the user to input data for the harrow operation.
6.	GRAIN DRILL	Prompts the user to input data for the grain drill operation.
7.	ROW PLANT	Prompts the user to input data for the planting operation.
8.	CULTIVATE	Prompts the user to input data for the cultivate operation.
9.	COMBINE	Prompts the user to input data for the combine operation.
10.	TOTAL OF ALL OPERATIONS	Displays total fuel consumption and fuel cost requirements for all operations run from the time the user enters RUN until the time Item number 10 is chosen.
11.	CHANGE INPUT PARAMETERS	Allows the user to re-input program options necessary to run the "user-interactive" version. Brief instructions also are given.
12.	STOP PROGRAM EXECUTION	When this item is chosen, program execution is halted.

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Establishment and Maintenance of Rabbiteye Blueberries

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Establishment and Maintenance of Rabbiteye Blueberries

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Establishment and Maintenance of Rabbiteye Blueberries

Establishing a blueberry plantation without careful planning is an exercise of poor judgment. Some of the more important considerations in preplanning are in the form of questions as follow:

1. Do I have an acceptable site?
2. What use do I plan to make of the berries? (the answer is important to selection of the proper varieties.)
3. Where can I get plants of the varieties I choose to grow?
4. Am I capable of handling the harvest?

These and other questions are addressed in this bulletin.

Establishment

Site Selection and Preparation

Rabbiteye blueberries grow well on many soil types but do best on light, well-drained soils with pH of 4.2 to 5.5. Low areas with a high water table are not recommended but can be used if the water table is 20 inches or more below the soil surface. A drainage system is recommended for sites with a water table less than 20 inches below the soil surface.

Have the soil tested and adjust pH to within the required range. Apply and incorporate elemental sulfur to increase acidity (lower pH) if pH is above 5.5. Apply and incorporate dolomitic or calcitic lime to decrease acidity (raise pH) if pH is below 4.2.

Do not burn windrows on newly cleared areas because the ash can raise pH above that of unburned areas on the site. If windrows have been burned, sample such areas separately and apply sulfur as indicated by soil-test results.

Note: If sulfur is required apply and incorporate it at least 6 months before setting plants.

Determine row direction and make a plat of the site (Figure 1). If the slope mandates contouring, seek assistance from the Soil Conservation Service. Plan for plant spacing of 6 to 8 feet on rows spaced 12 to 14 feet apart. The closer spacing permits more efficient mechanical harvesting, and the wider spacing often is used in pick-your-own operations. The 6 x 12 spacing gives 605 plants per acre; the 8 x 14 spacing, 389 plants per acre.

Prepare the site at least one season before planting. Subsoil to improve drainage and root penetration of soils with pans. A cover crop, such as millet, can be planted in early summer and incorporated into the soil in the fall. This can be followed with a winter crop, such as rye, if you plan to set plants in the spring.

Eradicate weeds the year before planting. This usually requires extensive cultivation and/or the use of a systemic herbicide for control of brambles, grasses with rhizomes and other hard-to-kill weeds.

Determine the varieties to be planted, select a source of plants and arrange to have them available at the expected time of planting.

The market to which the fruit will be sold bears importantly on the selection of varieties. Growers who plan to market on a local pick-your-own basis need to choose two or more varieties that yield fruit over a long

Table 1. Percent of total yield harvested at various picking intervals, 4-year average of 12 rabbiteye blueberries planted in 1979 at Poplarville, Mississippi, by variety and harvest interval.

Variety*	Harvest Intervals 5/20 - 6/15 %	6/16 - 7/8 %	7/9 or later %	Total Yield 1984 lb/plant
Aliceblue (E)	15	67	18	14.8
Beckyblue (E)	55	44	1	7.0
Bluebelle (M)	2	71	27	6.9
Briteblue (M)	12	69	19	11.0
Centurion (ML)	1	61	38	10.4
Climax (E)	47	46	7	9.5
Delite (ML)	5	82	13	5.3
Powderblue (ML)	16	66	18	9.9
Premier (E)	62	34	4	15.3
Southland (ML)	14	67	19	12.6
Tifblue (ML)	13	76	11	13.6
Woodard (E)	26	65	9	10.5

*Maturity: (E) Early, (M) Midseason, (ML) Mid- to late season.

Table 2. Fruit yields of 14 rabbiteye blueberry varieties planted in 1979 at Poplarville, Mississippi, by variety and year.

Variety*	Total Yield (lb/A) 1981	1982	1983	1984	1985
Aliceblue (E)	1,338	3,963	4,644	8,900	9,511
Beckyblue (E)	1,327	1,773	1,643	4,140	7,411
Bluebelle (M)	944	1,052	1,542	4,126	4,844
Briteblue (M)	887	3,902	3,510	6,616	9,849
Centurion (ML)	1,111	2,622	3,338	6,240	9,142
Climax (E)	804	1,164	3,513	5,717	8,543
Delite (ML)	406	1,662	2,111	3,168	4,163
Homebell (ML)	668	2,115	2,822	7,566	8,917
Menditoo (ML)	3,334	1,980	2,174	5,582	4,870
Powderblue (ML)	196	2,574	3,159	6,600	7,460
Premier (E)	647	2,435	3,200	9,184	8,620
Southland (ML)	1,024	2,920	3,462	7,581	9,909
Tifblue (ML)	48	2,348	3,213	8,190	10,744
Woodard (E)	871	2,486	3,794	6,305	8,207

*Maturity: (E) Early, (M) Midseason, (ML) Mid- to late season.

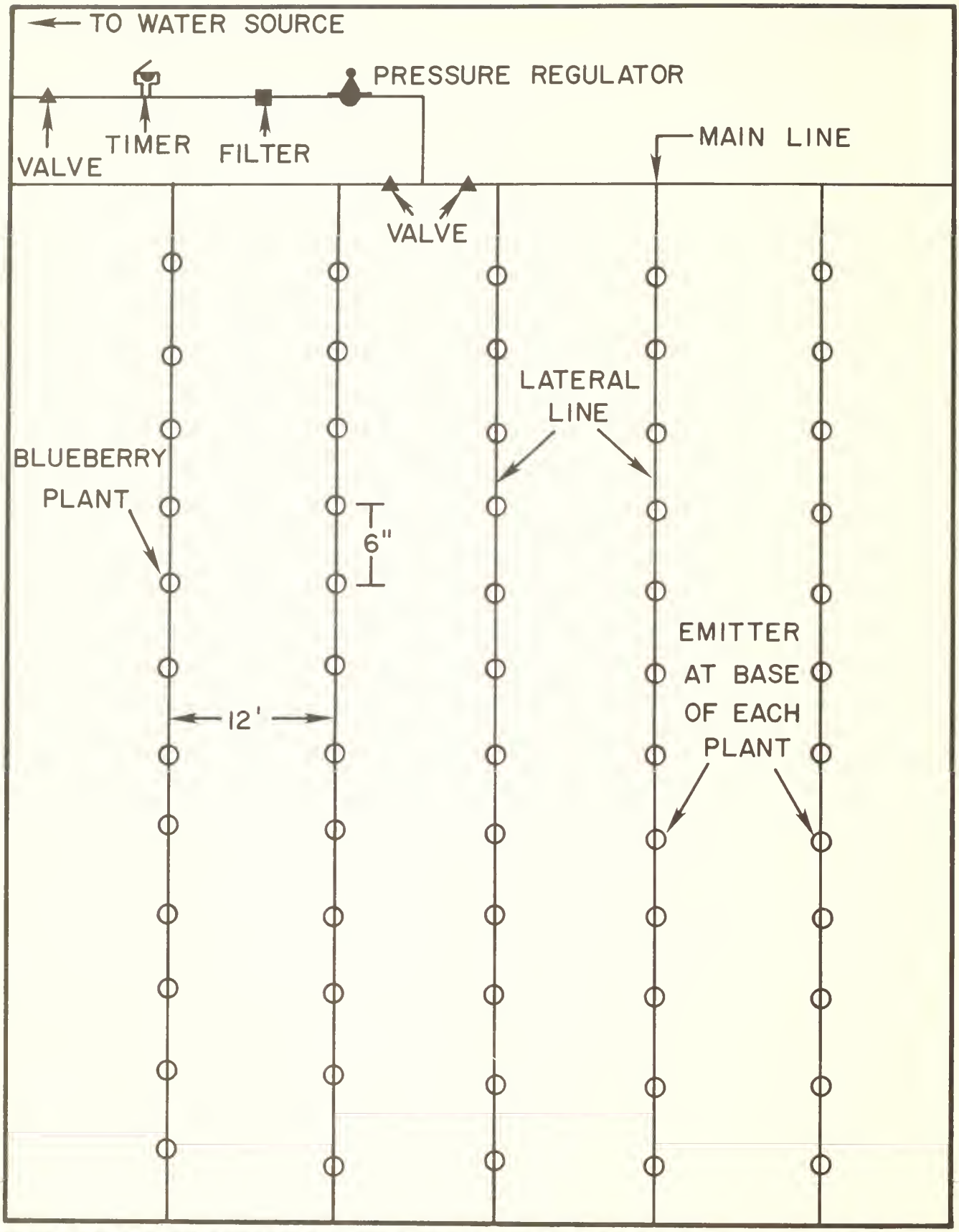

Figure 1. Plat of a trickle-irrigated blueberry plantation with plants 6 feet apart in rows spaced 12 feet apart.

Figure 2. Blueberry planting sites can be prepared using a middle-buster (left) to open rows or by digging a hole with a tractor mounted auger (right).

season (Tables 1 and 2). Those who plan to market through wholesale channels need to choose two or more varieties with peak ripening in early to midseason. (see Characteristics of Available Varieties, Appendix, Page 10.)

Irrigation

Select the irrigation system to be used and have it ready for operation before the newly set plants start to bud (Figure 1).

Setting Plants[1,2]

Plant at any time during the dormant season, usually from early December to early March.

Planting site preparation can be done in two ways: (1) by opening the rows with a middle-buster, placing the peat where the plant is to be set, mixing it into the soil with a rototiller and bedding back over the middlebuster furrow, or (2) by digging a hole about 2 feet in diameter and 2 feet deep with a soil auger (or shovel) and filling the hole with a mixture of peat and soil (Figure 2).

Caution: Wet the peat thoroughly before mixing with the soil or wet the peat-soil mixture thoroughly before setting plants.

Disturb the root mass of container-grown plants (Figure 3). Root pruning of bare-rooted plants is not necessary.

Prune plants to a height of 6 to 8 inches before planting. Set them ½ to 1 inch deeper than they were grown in the nursery.

Management

Fertilization

Rabbiteye blueberry plants are highly sensitive to readily soluble fertilizers, and excessive amounts can cause plant injury or death. *Never* fertilize in excess of soil-test recommend

Figure 3. Before planting container-grown plants, break up the root mass with a knife, hatchet, or other cutting tool. This is not necessary with bare-rooted plants.

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[1]*Check with the County Agricultural Agent or Cooperative Extension Service Specialist for reliable plant sources.*

[2]*Two-year - old bare-rooted or container-grown plants are preferred. Use healthy plants of named varieties.*

ed rates. *Never* concentrate fertilizer in a small area around plants. Do not apply nitrate forms of nitrogen. (*Note*: Ammonium nitrate can be used but other sources of nitrogen, such as ammonium sulfate, are preferable.)

First Year–Blueberries planted under irrigation in fertile soil with incorporated peat moss usually require no fertilization in the first growing season. However, growth of young plants sometimes can be increased by application of small amounts (1 ounce per plant in May and again in June) of a complete acid-forming fertilizer that contains nitrogen in the ammonium form (e.g., 14-4-8 or 14-8-8).

Second Year to Maturity–Apply the 14-4-8 or 14-8-8 complete acid-forming fertilizer in the second year at 2 ounces per plant in March and again in June. This amount can be increased in 2-ounce increments each year until the rate reaches 8 ounces per plant (see Fertilization, Appendix, Page 8). These rates have been proven adequate for blueberries with an adequate supply of soil moisture, and higher rates can be damaging (Figure 4). For example, the problem of plants with pale green or yellow leaves (chlorosis) and low vigor most likely is too much fertilizer and too little water.

The appearance of chlorotic plants of low vigor in adequately fertilized and irrigated orchards may indicate iron or magnesium deficiency. Deficiencies of these elements can be corrected by applying iron chelate or magnesium sulfate (epsom salts). (*Note*: Seek assistance from the County Agricultural Agent or Cooperative Extension Service Specialist if these symptoms appear.)

Irrigation

A dependable irrigation system is essential for successful establishment and growth of rabbiteye blueberries in the Gulf States region (Figure 1).

Irrigation in the first 2 years speeds establishment of uniform and healthy plants, and a small first crop from all plants in irrigated orchards normally is expected in the second year. Establishment of vigorous and productive plants without irrigation may require 3 or more years.

Irrigation of bearing orchards usually is most critical from the beginning of fruit set until harvest. Irrigation at this time increases fruit production, improves fruit quality and promotes growth of fruiting wood for the next year's crop.

Figure 4. Plants grown with low irrigation and low fertilizer application (left) and with low irrigation, high fertilizer (right).

Weed Control

Eradicating weeds the year before planting is vital to the success of establishing and growing weed-free rabbiteye blueberries–it minimizes the need for weed control in the first year of growth, and recommended herbicides can be applied safely in subsequent years.

One of two or more systems of management (depending upon soil type and topography) can be used for established plants.

Maintaining sod strips between weed-free rows (Figure 5) is recommended where erosion is likely. Sod strips also permit movement of equipment in wet periods. Other advantages are convenience to workers, pickers or pick-your-own customers. Sod strips can be seeded to grasses, or the natural vegetation can be left. In either event, the sod-strip cover should be of a type that offers little competition with the blueberry plants and is easily controlled. Clip the sod strips as needed to keep weeds from seeding.

Clean cultivation can be used in orchards where erosion is not a problem. Planting a winter annual in the row middles and disking it under in early spring is recommended. Disk the row middles periodically to keep weeds from seeding.

Use herbicides or shallow cultivation to maintain weed-free rows in each system. Several herbicides are labeled for use with blueberries. The County Agricultural Extension Agent or Cooperative Extension Specialist can assist with specific weed-control recommendations.

Mulching

Mulching with organic materials (such as bark, straw, or leaves) conserves moisture and gives some suppression of weeds. The economic feasibility of mulching commercial plantings is questionable, but

Figure 5. Sod strips in a young blueberry planting (left) and a mature planting (right).

mulching is highly recommended for home growers and growers with small numbers of plants.

Disease Control

Diseases seldom are a serious problem in rabbiteye blueberries. Rabbiteye blueberries are more resistant to fungal infections than are highbush blueberries.

Root rot can cause problems, especially in wet, poorly drained soils. Stem blotch is characterized by red blotches on the previous season's growth, and anthracnose can cause stem dieback on more susceptible varieties.

These and other reported diseases are found only in isolated situations and are not considered serious problems at present. There is no disease spray program for rabbiteye blueberries.

Insect Control

Rabbiteye blueberries are more resistant to insect damage than are highbush varieties. Relatively few insect species attack the rabbiteye varieties and, as with diseases, damage occurs in only isolated cases.

Insects known to attack rabbiteye blueberries include stem borers, cranberry fruit worm, leaf rollers, mites, bagworm, orange-striped oak worm, yellow-necked caterpillars and scales. Fire ants are a major problem during harvest and should be eliminated.

An insecticide spray program is not necessary because insect infestations are infrequent. However, you should monitor your orchard and spray with an approved insecticide if infestation is detected.

Pollination

Planting of two or more varieties is required for cross pollination to enhance fruit set, earlier ripening and larger fruit. The blooming interval of most available varieties overlaps sufficiently to assure adequate cross pollination. (see Pollination, Appendix, Page 9 for two planting-pattern designs.)

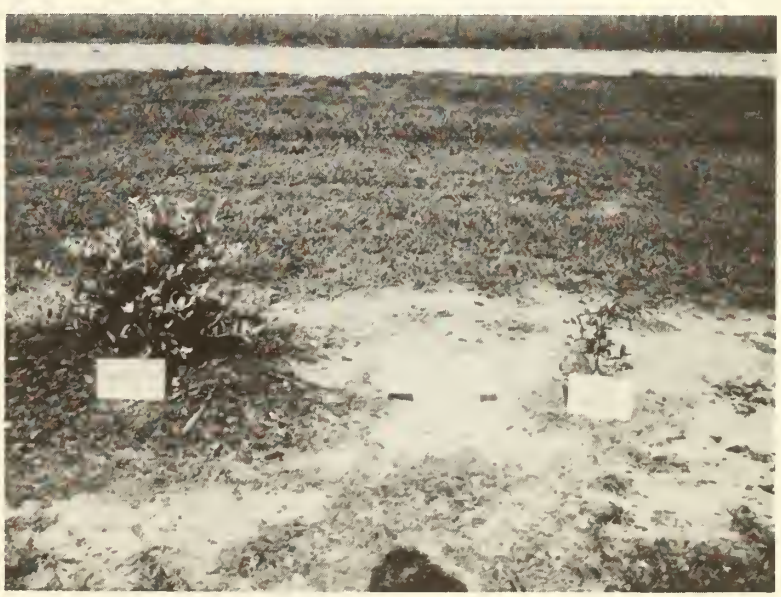

Figure 6. Significant differences are apparent between the unirrigated mulched plant (left) and the unirrigated and unmulched plant at right.

Bees are needed for pollination. Wild bees often are present in sufficient numbers to assure cross pollination in small plantings. Domestic honey bees (about one to two hives per acre) should be provided for large plantings and in areas with small populations of wild bees.

Pruning

Cut plants back to a height of 6 to 8 inches before planting. Remove all weak shoots and fruit buds. Additional pruning usually is not needed in the year of establishment.

Pruning in the second through fifth years consists mainly of removing the lower twiggy growth, dead or damaged shoots and weaker growth. In the post-harvest season, remove the top one-third of tall shoots to encourage lateral branching and prevent excessive drooping in the next fruiting season. Shape plants for mechanical harvesting by removing all shoots growing outside a 12-inch band within the row.

Prune mature plants immediately after harvest. This permits shoot regrowth and flower bud formation before plants become dormant (Figure 7).

When plants become too tall to harvest easily, summer prune immediately after harvest to reduce top height by selective removal of about one third of the older canes. This permits better light penetration into the center of the plant.

Harvesting

Harvesting begins in late May in Florida and continues into August in North Carolina. The Mississippi harvest normally runs from early June to late July.

Picking of most varieties should begin one to two weeks after the first blue color appears or three to six days after the fruit is completely blue. Berries harvested too early are smaller, are of poorer quality and contain less sugar.

Most rabbiteye plantings are of 10 or less acres, and the crop usually is harvested for fresh market or by pick-your-own customers. Berries should be hand picked at about one-to two-week intervals, depending on rate of ripening.

Mature rabbiteye plants normally produce 20 pints or more per bush, and four to six pickers are required for harvesting one acre. Fruit damage is reduced by picking directly into the containers in which the fruit will be sold on the fresh market. Careful grading by the picker is required if this method is used. Early morning picking is recommended, and immediate placement in coolers or in a shaded area is essential for maintenance of top quality.

Two types of mechanical harvesting aids are available–a hand-held

Figure 7. Drawings show plant before pruning (left) and after pruning (right).

haker and an over-the-row harvester Figure 8). Both types remove some wigs, leaves and undesirable fruit; herefore, cleaning is necessary. Cleaning usually is accomplished with a blower unit that removes most eaves, small twigs and small immature berries and a conveyor belt to facilitate removal of the remaining undesirable fruit and foreign matter which may be present.

Shelf life of machine-harvested berries is shorter than that of those that are hand picked and should not be moved into fresh-market channels unless it can be made available to consumers without delay. Much of the mechanically harvested fruit is frozen, dried or used in pies, pastries and other prepared foods.

Note: See MAFES Research Report Vol. 8, No. 8 for information on cost comparisons for hand and mechanical harvesting.

Figure 8. Harvesting with a hand-held shaker (left) and over-the-row harvester (above).

Appendix

Fertilization

Finding a complete acid-forming fertilizer is difficult because most commercially available complete fertilizers have a lime-containing filler. Workers at the USDA Small Fruits Laboratory at Poplarville, Mississippi have developed a good blueberry fertilizer (14-8-8 analysis). The nitrogen sources are ammonium sulfate and diammonium phosphate, and the filler is cottonseed meal. Contact the County Agricultural Agent or Cooperative Extension Service Specialist for sources.

General recommendations for using this formulation on most plantings are shown in the following table:

Years Plants have been in field	Recommended rates*
2	400 lb/acre** 2.5 oz/plant***
3	680 lb/acre 4 oz/plant
4-5	1,020 lb/acre 6 oz/plant
6 or more	1,361 lb/acre 8 oz/plant

* Recommended rate should be applied as split applications, one-half in March and one-half in June.

** Fertilizer broadcast evenly over the entire acreage supplies nutrients equally to plants and sod and will help maintain uniform pH and fertility over the entire area.

*** Applied to a 16 sq ft area beneath each plant and is only 22% of the per acre recommendation. Spread the recommended amount equally over the 16 sq ft area.

Irrigation

Blueberry plants require from 1 to 2 inches of water per week in the first year or two of growth. Upland soils in the Gulf States region are well drained but have low water-holding capacity. Short periods (1-3 weeks) without rain can stress blueberry plants severely. Irrigation during such periods is required for optimum plant performance.

The rapid decrease in soil moisture during dry periods increases the concentration of fertilizer nutrients in the soil solution, which may damage plants. Irrigation lowers the concentration of nutrients in the soil solution, and this reduces the risk of fertilizer damage.

Trickle irrigation–This is the most efficient method but requires a filtering system for muddy water from ponds or lakes. Excellent results have been attained with two in-line swimming pool sand filters. Water from most wells can be filtered inexpensively unless it has high iron content.

The trickle irrigation system operates on low water pressure and consists of polyethylene tubing laid down the row (buried or on top of the ground) with an emitter placed above ground beneath each plant (Figure 9). A calculated amount of water is discharged on the soil surface beneath each plant. The recommended rate is 2 to 8 gallons per plant per week, which may be in split applications. Water requirements increase as plants increase in age and size.

This system operates under low pressure and requires less water for a given area, thereby increasing efficiency of the pump.

Flood (furrow) irrigation–The orchard must be on land with a slope that permits water to flow freely from the high to the low end of the orchard.

Sprinkle (overhead) irrigation–This type of irrigation requires high operating pressure to distribute large volumes of water. Another disadvantage is wetting of foliage, which can create and/or compound disease pro-

Figure 9. Trickle irrigation.

blems. Advantages are that it may be used for frost control and activation of herbicides.

Pollination

Planting the same variety on a row is advantageous for ease of harvesting. Irrespective of the number of varieties in an orchard, always plant each variety adjacent to a different variety to provide cross pollination. Two designs of a six-row planting of two varieties are diagrammed below:

½ variety A
½ variety B

A
B
B
A
A
B

⅔ variety A
⅓ variety B

A
B
A
A
B
A

Propagation

Rabbiteye blueberries usually are propagated from softwood or hardwood cuttings selected from healthy, disease-free mother plants. Cuttings are placed in a propagation bed in a medium that holds moisture well but allows adequate aeration. Water is delivered with an intermittent mist-watering system (Figure 10).

Softwood Cuttings–Softwood cuttings (4-5 inches long) are taken in late spring from the tips of the current season's growth. These should be collected when stems are still somewhat flexible and terminal leaves are half-grown to almost mature (Figure 11). Cuttings taken too early (terminal leaves very succulent, stems very flexible) wilt readily. If cuttings are taken too late (mature leaves, second flush of growth initiated), poor rooting will occur. Rooting usually is more successful when cuttings are obtained from the first flush of spring growth. However, cuttings can be collected from growth flushes occurring later in the growing season.

Take cuttings from the upper part of the mother plant. Use sharp, clean pruning shears or knives disinfected in solution of 1 part household bleach:5 parts water. Disinfect tools between mother plants. Remove lower leaves by pulling them upward to avoid tearing of bark, leaving the two or three terminal leaves. Don't allow cuttings to dry; keep them moist and cool after collection. Place cuttings in propagation bed as soon as possible at a depth of one-half to two-thirds of their length (Figure 10). Cuttings are usually planted at a 2-inch by 2-inch spacing. Pre-punching holes in media is often advantageous. Firm media around the base of cuttings to avoid air pockets.

Hardwood Cuttings–Hardwood cuttings are taken

Figure 10. Softwood cuttings properly set in a propagation bed with mister off (above) and on (below).

Figure 11. Softwood cuttings: left, too young and succulent; center, proper stage of growth; right, too old.

Figure 12. Hardwood cuttings.

during the dormant season after sufficient chilling has occurred, usually late January through February. Strong, healthy shoots or "whips" (usually 12-36 inches long) that grew the previous summer are collected. These "whips" are divided into sections 5 to 6 inches long (Figure 12) with a sharp knife or a bench saw with a fine blade. If the terminal of the shoot contains flower buds, remove the flower buds or discard the tip.

The same beds and media used for softwood propagation can be used for hardwood cuttings. Cuttings are inserted into the medium from one-half to two-thirds of their length. The medium should be pressed firmly around the base of cuttings which are usually spaced 2 inches by 2 inches. Propagation beds must be kept moist, but care must be taken to avoid using too much water. Hardwood cuttings can be watered with a sprinkler until they leaf out, then mist watered while in leaf but not yet rooted.

After cuttings are rooted, a weak complete liquid fertilizer can be applied weekly. Plants can remain in the propagation bed until winter (use little or no fertilizer in this case) when they should be transplanted into pots or nursery beds and held for one year. If plants are strongly rooted by June or July, they can be transplanted to pots, placed under shade, and fertilized with a slow-release complete fertilizer 2 weeks after transplanting. This method often results in plants large enough for field planting in the next winter.

Propagation beds need to be well-drained, under shade cloth (40-70% shade), and have adequate ventilation. Avoid excessive wind movement that may interfere with mist control.

Propagation Media—A medium that retains moisture well but allows aeration is necessary. Media containing various propagation mixtures of coarse sand, ground pine bark, perlite, sawdust, and peat moss have proven satisfactory. Root development is best when the rooting medium contains at least 25-50% peat moss. Mixtures of coarse sand, ground pine bark, and peat moss (1:1:1), or perlite and peat moss (1:1) often are used.

Mist System—The mist system should keep the media uniformly moist but not soggy. If you can squeeze out only a few drops of water from a handful of media, you probably have the correct amount of moisture. An intermittent-mist water system is needed to keep the humidity around the cutting near 100%, prevent wilting, and keep the medium moist. Starting with a porous medium that holds moisture well, adjust the mist system to maintain turgid (non-wilted) leaves and high humidity. Frequent (2-10 minutes) short misting intervals (2-10 seconds) are recommended.

Characteristics of Available Varieties*

Early Season

Climax—upright, open plants. Berries are medium in size, medium dark blue in color, have a small scar and good flavor. Early season, ripening three to five days before Woodard. Concentrated ripening, excellent for machine-harvest. Georgia 1976.

Woodard—early, seven to ten days before Tifblue. Bush size shortest and most spreading of Georgia varieties. Produces many suckers. Berries are light blue,

*The ripening seasons described herein are generalizations for the Gulf States region and may differ among locations in the region. For example, Aliceblue is listed herein as early season, but its ripening peak at Poplarville, Miss. is in mid-season (see Table 1).

irm, large, with excellent quality when fully ripe but ery tart until ripe. Georgia 1960.

Brightwell—early, same season as Woodard. Berries re medium in size and in blue color, with small dry scars nd good flavor. Plant growth is vigorous, upright and roduces enough new canes to renew the plant. Georgia 981.

Premier—earlier (two to three weeks) than Tifblue. arge fruit with good flavor. Vigorous, disease resistant, roductive. North Carolina 1978.

Beckyblue—early ripening. has a low chilling requirement. Extends the cultural range of rabbiteye blueberries into South-Central Florida. Interplant with Aliceblue. Not recommended north of North Florida. Florida 1978.

Aliceblue—early ripening with low chilling requirement. Similar to and should be interplanted with Beckyblue. Florida 1978.

Mid-season

Briteblue—bush moderately vigorous, grows upright and open. Mid-season, generally before Tifblue. Berry firmness, heavy bloom, and small dry scar combine to make this a good shipper. Fruit with good flavor when fully ripe. Georgia 1969.

Bluebelle—excellent pick-your-own cultivar. Berries large, round, light blue with excellent flavor that size well throughout the season. Mid-season. Plants moderately vigorous with upright growth. Scar tends to tear, not recommended for shipping. Georgia 1976.

Mid-to-late Season

Tifblue—leading rabbiteye variety. Bush very vigorous and widely adapted. Mid-to-late season. Fruit large, round, light blue, sweet, very firm with small dry scar. Berries appear to be ripe several days before full flavor develops. Berries remain on plant several days after fully ripe. Georgia 1955.

Delite—upright bush. Moderately vigorous. Season slightly later than Tifblue. Berries are light blue, often with reddish undercoat; large, firm with excellent flavor. Berries are not tart before reaching maturity. Georgia 1969.

Southland—moderately vigorous, dense upright plant. Berries are light blue, medium large with good flavor. Tend to lose size as season progresses. Same season as Tifblue. Scar small and dry. Georgia 1969.

Powderblue—vigorous, disease resistant, productive. Same season as Tifblue with better fruit color and more foliage disease resistance. North Carolina 1978.

Centurion—later than Tifblue. Adds one or more weeks to the rabbiteye ripening season in North Carolina. Good flavor, not as firm and darker than Tifblue. North Carolina 1978.

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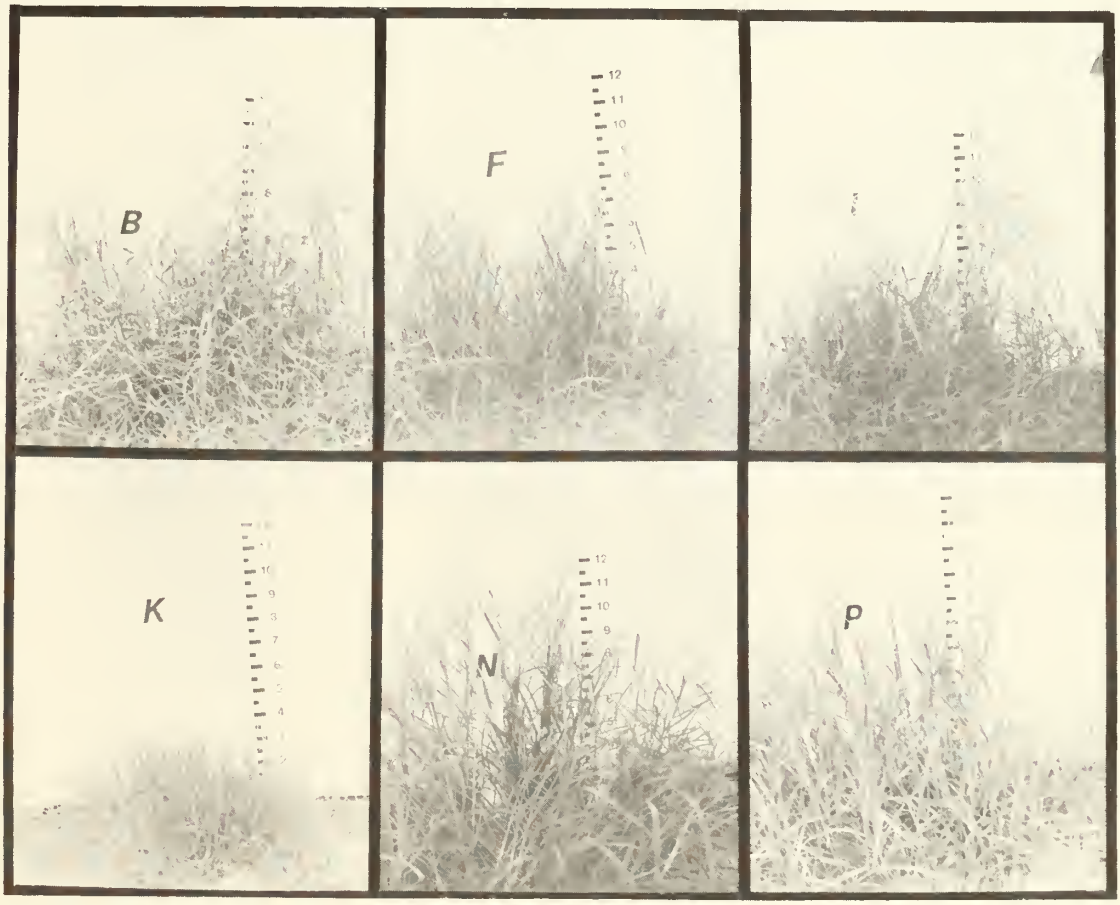
Effectiveness of Grass Herbicides on Different Types of Bermudagrass



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Cover photograph shows examples of differences in bermudagrass types collected from several locations. Of the 17 biotypes included in this study, many are similar to one another as shown by the top three specimens (B, F, I). Others vary noticeably in length and width of leaves and in length and number of seed heads as the bottom three specimens (K, N, P) pictured. Susceptibility to herbicides also varies among bermudagrass biotypes.

Effectiveness of Grass Herbicides on Different Types of Bermudagrass

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Table 1. Origin of bermudagrass biotypes collected in cotton fields and at federal and state forestry nurseries in the Lower Mississippi Valley Region.

Letter designation	Place of Origin State. County: Location, Source area.
A	MS. Bolivar Co.: Shaw, cotton field.
B	MS. Bolivar Co.: Duncan, cotton field.
C	MS. Tunica Co.: Tunica, cotton field.
D	MS. Coahoma Co.: Int Hwy 61 and 316, cotton field.
E	MS. Leflore Co.: Int Hwy 82 and 49E, cotton field.
F	MS. Quitman Co.: Marks, cotton field.
G	MS. Tallahatchie Co.: Tutwiler, cotton field.
H	MS. Issaquena Co.: Mayersville, cotton field.
I	MS. Humphreys Co.: Silver City, cotton field.
J	MS. Perry Co.: Brooklyn, W. W. Ashe Federal Nursery.
K	MS. Perry Co.: Brooklyn, W. W. Ashe Federal Nursery.
L	MS. Covington Co.: Mt. Olive, Mt. Olive State Nursery.
M	MS. Montgomery Co.: Winona, Winona State Nursery.
N	AR. Pulaski Co.: Little Rock, Baucum State Nursery.
O	LA. Caldwell Parish: Columbia, State Forestry Nursery.
P	TN. Madison Co.: Pinson, Pinson State Nursery.
Q	TN. Madison Co.: Pinson, Pinson State Nursery.

plant was watered daily. The plants were fertilized with a solution of NPK (20-20-20) at 0.2 ounces per gallon and trimmed to 1.5 inches in length every 3 to 4 weeks. The plants were grown in the greenhouse at 75 to 90° F for 18 weeks before being transplanted into the field.

Land preparation, field establishment, and plot maintenance. Field studies were conducted during 1982 and 1983 on a Dundee very fine sandy loam soil (Aeric Ochraqualfs). Treflan® (trifluralin) was applied over-the-top and double-disk incorporated, followed by preparation of rows 40 inches apart. On May 3 and 4, 1982, all the bermudagrass biotypes were transplanted in a zigzag arrangement 40 inches apart in two-row plots 80 feet long. After the biotypes were transplanted, a four-row roller was used to compress the soil around the bermudagrass. On April 26, 1983, those biotypes which were killed or stunted by one of the herbicide treatments during 1982 were replaced with the respective biotypes. Each replacement was established in the greenhouse by the same method described in the initial field establishment.

Bermudagrass growth prior to and during the experiment was confined within the prescribed area using Paraquat® (paraquat) at 2.5% v/v in water, applied with a hand sprayer at low pressure on days with little or no wind. Weeds in the plots were controlled with Cotoran® (fluometuron) applied broadcast at 1 pound in 20 gallons of water per acre 2 weeks prior to treatment in 1982 and 1983. Basagran® (bentazon) at 1 lb/acre and Blazer® (acifluorfen) at 0.25 lb/acre plus 0.25% v/v of Sterox NJ® (nonoxynol) were applied broadcast in 20 gallons of water per acre on July 20 and 28, 1983, and 2,4-D at 1 lb/acre was applied broadcast in 20 gallons of water per acre on August 1, 1983 for broadleaf and sedge control. These herbicides could have altered the amount of bermudagrass control, but such interactions could not be determined with the experimental design used. In addition, weed control was supplemented by hand-hoeing and spot treatments with a hand-held sponge applicator containing a mixture of water and Roundup® (glyphosate) (3:1, v/v). Each plot was fertilized at the rate of 450 pounds of ammonium nitrate per acre in 1982 and in 1983.

Experimental design and treatment. The experiment was established as a split-split-plot design with herbicides as main plots, rates as subplots, and bermudagrass biotypes (A through Q) as sub-subplots replicated three times. Herbicide rates were chosen from preliminary studies. The rates used were those resulting in a measurable degree of bermudagrass control without killing the most susceptible biotypes. All rates are expressed as pounds of active ingredient (ai) per acre. Herbicide treatments were applied postemergence on June 21, 1982 and 1983, using Poast® at 0.5 and 1 lb/acre, Fusilade® (fluazifop) at 0.25 and 0.5 lb/acre, Verdict® (haloxyfop) at 0.25 and 0.5 lb/acre, Assure® (DPX-Y6202) at 0.25 and 0.5 lb/acre, and Whip® (fenoxaprop) at 0.25 and 0.5 lb/acre. Each was applied with 0.5% v/v Atplus 411F® [polyoxyethylene sorbitan fatty acid ester: mineral oil (17:83% w/w)]. (Atplus 411F® is a product of ICI Americas Inc., Wilmington, Delaware.) Other treatments were Roundup at 1 and 2 lb/acre and Dalapon at 5 and 10 lb/acre, each with 0.5% v/v Sterox NJ. Herbicide treatments were applied in 20 gallons of water per acre with a tractor-mounted air-pressure sprayer equipped with 8003 spray tips with no-drip strainers, at 20 psi pressure.

Control evaluations. Bermudagrass control was determined 2, 4, 7, and 13 weeks after treatment by a visual plant damage rating system on a scale of 0 to 100 where 0=no control, and 100=complete control. The data were subjected to an analysis of variance. Years, herbicide levels, and biotypes were compared by Duncan's multiple range test (DMRT) at the 5% level of significance.

Results and Discussion

Early season control of the different bermudagrass biotypes using the lower rate of each herbicide is shown at 7 weeks after treatment in 1982 (Table 2) and 1983 (Table 3). Other workers have shown that weed competition during this first 6 to 8 weeks after planting results in the greatest yield reduction of soybeans (2, 18) and cotton (3). Like previous reports of differential susceptibility to herbicides of biotypes of johnsongrass (7, 8, 12), quackgrass (5), and bermudagrass (1, 5, 9, 13, 14, 15, 16, 18), control varied among bermudagrass biotypes in this study.

Results 7 weeks after treatment showed significant variations in the percent control between the most susceptible to the most resistant biotypes. The range of percent control among the different biotypes was greatest (>45%) using Poast and Fusilade and least (12%) using Verdict. The variations in percent control among biotypes were more pronounced using the lower rate than the higher rate of each herbicide.

Season-long control averaged over all bermudagrass biotypes for each of 2 years was greatest with Verdict at 0.5 lb/acre (>95%) and least with Whip at 0.25 lb/acre and Dalapon at 5 lb/acre (<20%) (Figure 1).

When results were averaged over all biotypes for both years, Whip at 0.25 lb/acre gave a maximum control of only 48% 2 weeks after application, with a rapid decline in control to 16% by 13 weeks after treatment. Data are presented by years (Figure 1); averages over both years are not shown. Whip at 0.5 lb/acre resulted in 58% to 55% control at 2 and 4 weeks after treatment, but control rapidly declined to 19% at 13 weeks after treatment. Likewise, Dalapon at 5 and 10 lb/acre, Poast at 0.5 and 1 lb/acre, Roundup at 1 and 2 lb/acre, Fusilade at 0.25 lb/acre, and Assure at 0.25 lb/acre gave maximum control at 4 weeks after application. By 13 weeks after treatment, control had declined greatly with each of these herbicides except for Roundup at 2 lb/acre, which showed only a slight decrease in control from 81% at 4 weeks to 70% at 13 weeks. Seven weeks after treatment, Fusilade at 0.5 lb/acre, Assure at 0.5 lb/acre, and Verdict at 0.25 lb/acre produced a maximum control of 81, 81, and 94%, respectively. Verdict was the only herbicide with which control was slightly higher at 13 than at 7 weeks after treatment in both years.

During 1982 and 1983, control of bermudagrass biotypes from cotton fields was not significantly different (p = 0.05) from biotypes collected in state and federal nurseries (data not shown). For all herbicides and application rates, control of bermudagrass biotypes significantly differed (p = 0.05) between the years 1982 and 1983. At 13 weeks after treatment, differences in control between 1982

Table 2. Comparative percent control of bermudagrass biotypes 7 weeks after treatment in 1982[1].

Bermudagrass Biotype	Herbicide (lb ai/acre)						
	Poast® (0.5)	Fusilade® (0.25)	Verdict® (0.25)	Assure® (0.25)	Roundup® (1.0)	Whip® (0.25)	Dalapon® (5.0)
A	73 a-d	83 a-d	93 a	72 a	82 a	13 c	27 cd
B	75 a-c	75 a-f	87 a	80 a	87 a	20 bc	78 a
C	70 a-d	78 a-e	90 a	82 a	73 a	12 c	77 a
D	45 e	62 d-g	95 a	72 a	62 ab	17 bc	13 cd
E	78 a-c	67 c-g	96 a	78 a	82 a	26 a-c	10 d
F	57 c-e	57 e-g	96 a	85 a	68 ab	13 c	20 cd
G	60 b-e	52 fg	99 a	85 a	70 ab	13 c	17 cd
H	65 a-e	68 b-g	88 a	73 a	38 c	13 c	27 cd
I	88 a	93 ab	99 a	85 a	87 a	45 a	13 cd
J	83 ab	98 a	99 a	80 a	73 a	45 a	37 bc
K	73 a-d	47 g	99 a	68 a	82 a	35 a-c	32 b-d
L	60 b-e	70 b-g	98 a	72 a	77 a	23 a-c	33 b-d
M	87 a	88 a-c	96 a	78 a	77 a	40 ab	52 b
N	50 de	90 a-c	96 a	80 a	48 bc	33 a-c	22 cd
O	57 c-e	95 a	98 a	83 a	82 a	40 ab	51 b
P	70 a-d	77 a-e	98 a	85 a	84 a	40 ab	32 b-d
Q	43 e	62 d-g	94 a	70 a	83 a	13 c	13 cd
Mean	66	74	95	78	74	26	33
Range	88-43	95-47	99-87	85-68	87-38	45-12	78-10

[1]Numbers within columns followed by the same letter are not significantly different according to Duncan's multiple range test at the 0.05 level. The LSD for comparing numbers within columns is 20; the C.V.% is 18.

and 1983 averaged over the two herbicide rates varied 38, 30, 22, 12, 12, and 4% with Poast, Whip, Roundup, Fusilade, Dalapon, and Assure, respectively (data not shown). In 1982, control with Verdict was about the same as in 1983 (93-94%). Verdict and Assure were least affected by season-long environmental differences in 1982 and 1983 (Figure 1).

Season-long control using Poast at 1 lb/acre and Dalapon at 5 and 10 lb/acre was unacceptable under non-competitive growing conditions (Figure 1). Similar results were reported by Chandler (5). Likewise, Whip at 0.25 and 0.5 lb/acre provided unacceptable control over all bermudagrass biotypes. Fusilade at 0.25 lb/acre and Roundup at 1 lb/acre gave only fair control and resulted in a wide range of susceptibility among biotypes.

This collection of bermudagrass biotypes does not represent all of the possible genetic variability nor the full range of potential differences in herbicidal susceptibility within this geographical area. However, our data demonstrate that within any given year, there are differences in the comparative herbicidal susceptibility in bermudagrass biotypes from a wide area within the lower Mississippi River Valley region. While no one biotype was significantly more susceptible or tolerant to all herbicides, Verdict provided consistent acceptable control (>80%) of all bermudagrass biotypes over both years. These data are helpful in making recommendations for the control of a wide range of bermudagrass biotypes.

Acknowledgments

Appreciation is extended to J. M. Chandler, Agronomist, for the collection of these bermudagrass biotypes, to Terry E. Newton, Research Technician, for the excellent assistance and sincere interest in this study; to Debbie Boykin, Statistician, who added valuable assistance in data analysis; and to Lisa Kent, Research Technician, for graphics preparation.

Table 3. Comparative percent control of bermudagrass biotypes 7 weeks after treatment in 1983[1].

Bermudagrass Biotype	Herbicide (lb ai/acre)						
	Poast® (0.5)	Fusilade® (0.25)	Verdict® (0.25)	Assure® (0.25)	Roundup® (1.0)	Whip® (0.25)	Dalapon® (5.0)
A	53 a-c	78 a	93 a-c	89 a-b	47 b	22 a-c	37 c-e
B	33 de	68 ab	93 a-c	62 c	40 b	15 bc	45 a-d
C	43 b-d	87 a	92 a-c	62 c	68 a	28 ab	50 a-c
D	33 de	62 ab	95 a-c	91 a	70 a	28 ab	38 b-e
E	65 a	88 a	93 a-c	88 ab	73 a	30 ab	35 de
F	52 a-c	60 ab	87 c	94 a	47 b	23 a-c	33 de
G	48 bc	57 ab	94 a-c	88 ab	65 a	27 a-c	30 e
H	40 cd	60 ab	88 bc	78 a-c	52 b	15 bc	45 a-d
I	40 cd	88 a	99 a	88 ab	63 a	35 a	37 c-e
J	57 ab	68 ab	96 ab	93 a	70 a	20 a-c	38 b-e
K	43 b-d	32 d	96 ab	57 c	47 b	13 bc	37 c-e
L	18 f	60 a-c	91 a-c	73 bc	50 b	17 a-c	55 a
M	52 a-c	86 a	94 a-c	75 a-c	63 a	18 a-c	53 a
N	53 a-c	70 ab	94 a-c	92 a	55 a	13 bc	53 a
O	33 de	68 ab	92 a-c	94 a	73 a	28 ab	47 a-d
P	22 ef	60 a-c	96 ab	98 a	63 a	12 bc	52 ab
Q	25 ef	45 c	92 a-c	62 c	63 a	8 c	47 a-d
Mean	42	67	93	81	59	21	46
Range	65-18	88-32	99-87	98-57	73-40	38-8	55-30

[1]Numbers within columns followed by the same letter are not significantly different according to Duncan's multiple range test at the 0.05 level. The LSD for comparing numbers within columns is 19; the C.V.% is 19.

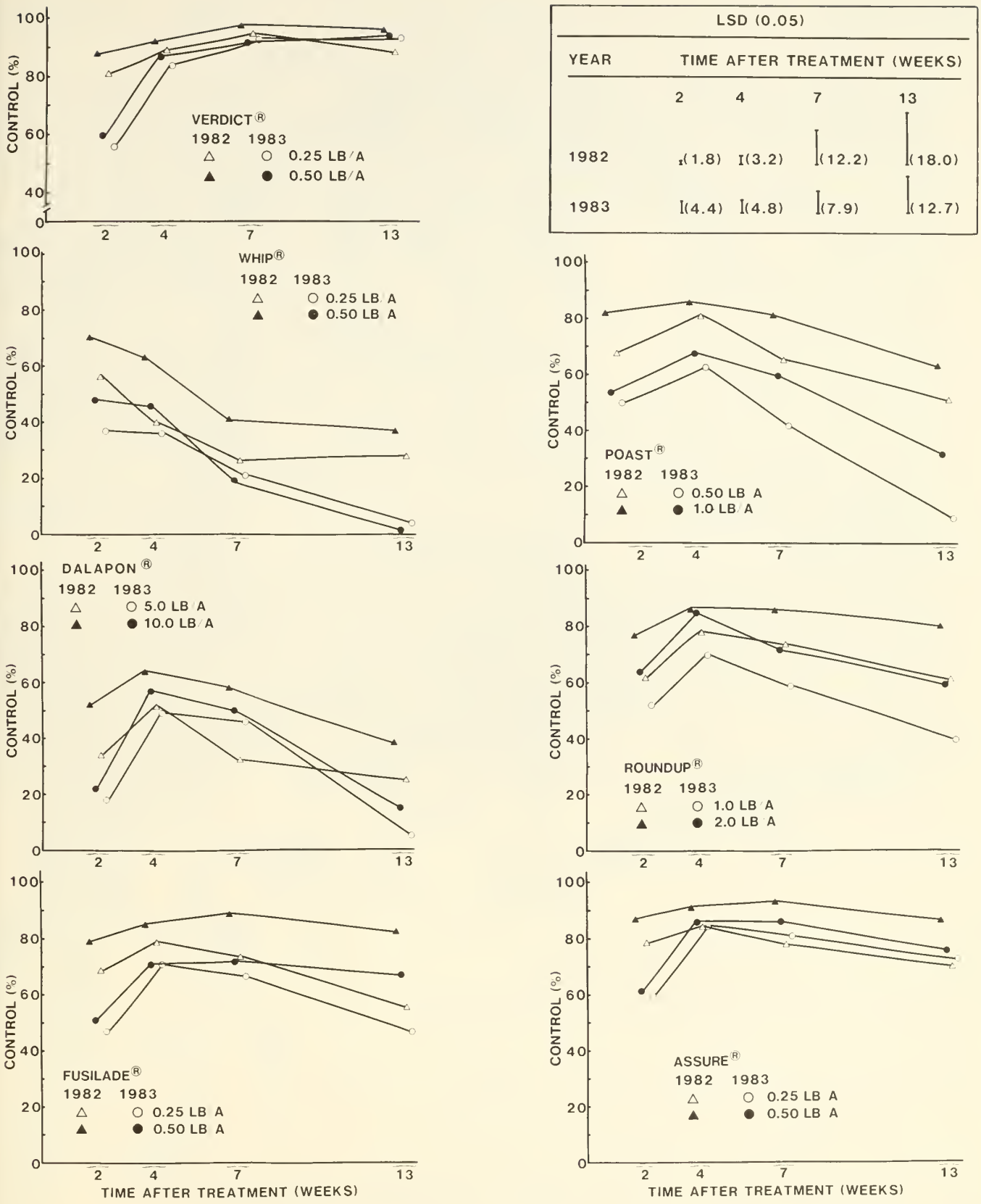

Figure 1. Effects of herbicides on bermudagrass at 2, 4, 7, and 13 weeks after treatment. Data are mean percent control averaged across 17 biotypes. LSD values for each year are over seven herbicides at both rates.

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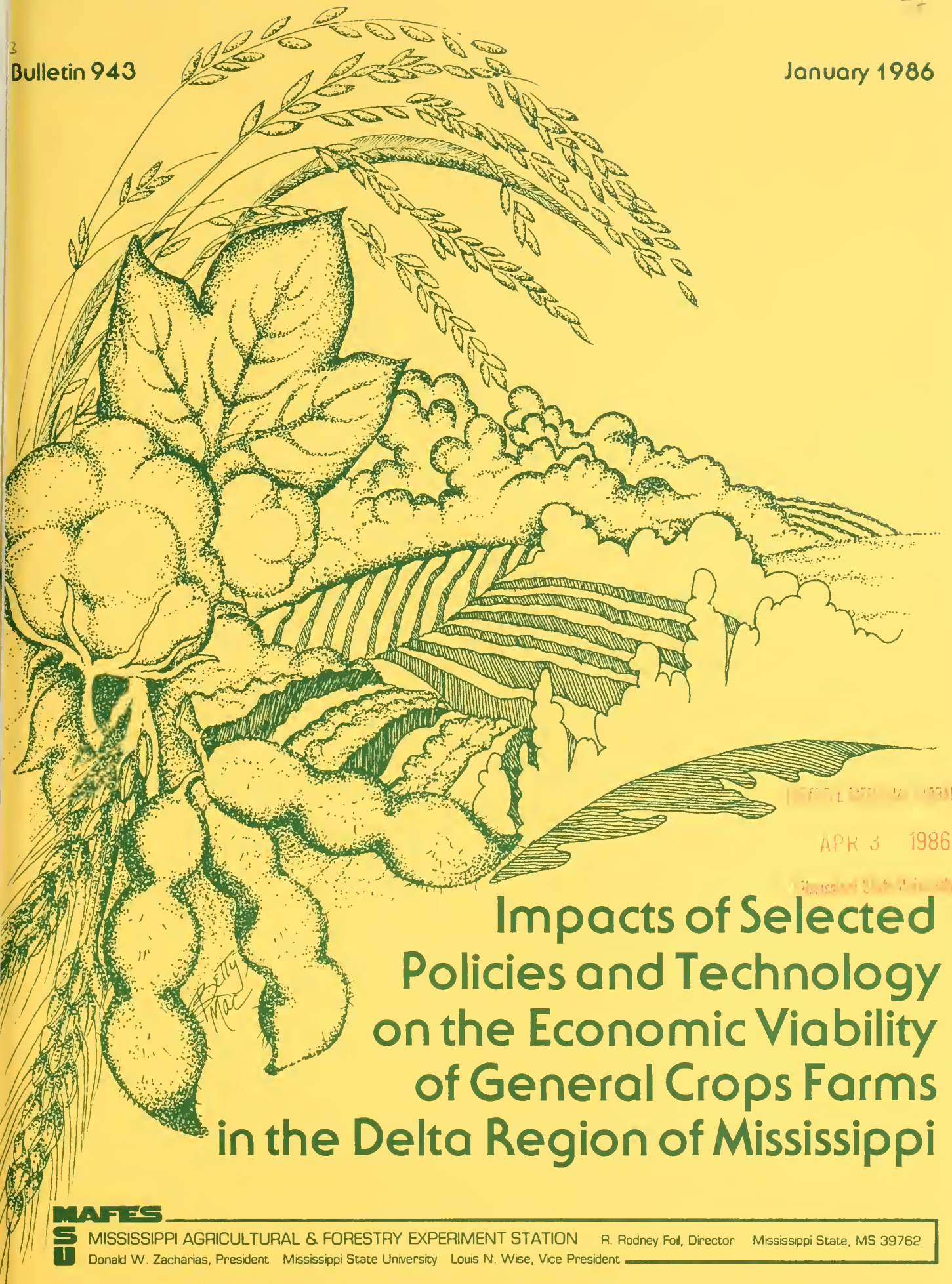

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Impacts of Selected Policies and Technology on the Economic Viability of General Crops Farms in the Delta Region of Mississippi

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Summary of Study Procedures and Results

Purpose and Methods

This study analyzes the impacts of selected farm commodity programs, federal income tax provisions, and farm-level production technologies on the economic viability of representative crop farms in the Delta Region of Mississippi. Each farm produces cotton, rice, soybeans, and wheat. The sizes of farms were selected to represent a moderate-size (1,443-acre) farm, a large (3,119-acre) farm, and a very large (6,184-acre) farm.

Computer simulation was used to analyze the effects of seven alternative farm commodity programs under current income tax provisions, one alternative income tax situation, three financial stress conditions, and three alternative technology advance possibilities on the income, wealth, and growth characteristics of each farm. The specific simulations were as follows:

Farm Policy Scenarios

I. Base Policy–The Base Policy Scenario involves continuation of the 1981 Farm Bill through 1992 and continuation of the income tax provisions under the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA). Annual crop yields were projected under the most likely technology advance conditions.

II. A 20% Acreage Reduction–The provisions of the Base Policy were modified by adding a 15% set aside with a 5% paid diversion for cotton, rice, and wheat in 1986-1992.

III. No Farm Program Payment Limitation–All provisions of the Base Policy were used except that the $50,000 limitation on diversion and deficiency payments was removed.

IV. No Price Supports/No Diversion Payments–The Commodity Credit Corporation loan, Farmer-Owned Reserve, and target price provisions under the Base Policy were eliminated for all years in the 1983-1992 planning horizon.

V. No Target/Deficiency Payment–The target price and deficiency payment program under the Base Policy was eliminated for all years in the 1983-1992 period.

VI. Target Farm Program Benefits–All farm program and income tax provisions of the Base Policy were used except that farms producing more than $300,000 of program commodities annually, valued at their localized loan rate, were not permitted to participate in the program.

VII. No Farm Program–All farm program provisions under the Base Policy were eliminated for all 10 years of the planning horizon.

Income Tax Scenario

VIII. Reduced Income Tax Benefits and Base Policy Program–The federal income tax provisions under TEFRA for the Base Policy were made more restrictive with regard to depreciation, first year expensing, investment tax credit, annual interest expense, and recapture of depreciation deduction provisions.

Financial Stress Scenarios

IX. Base Finance Policy–Each farm's long-term debt to asset ratio was increased to 0.55 and its intermediate-term debt to asset ratio was increased to 0.60 to represent a highly leveraged farm. Annual long-term and intermediate-term interest rates were increased to their 1980-83 average values. The Base Policy provisions were used to represent the farm commodity programs.

X. Debt Restructure–The Base Finance Policy provisions were used, but the length of intermediate-term loans was increased 1 year (to 7 years) and a portion of intermediate-term debt was converted to long-term debt.

XI. Interest Subsidy–The Base Finance Policy provisions were simulated, but an interest subsidy of 3.4% for long-term interest rates and 5.4% for intermediate-term interest rates was provided during the first 2 years.

No New Technology Scenarios

XII. No New Technology and Base Policy–The federal income tax and farm program provisions in the Base Policy (Scenario I) were simulated assuming that no new technology would be introduced during the 1983-1992 period.

XIII. No New Technology and No Deficiency Payments–The farm program provisions under No Target Price/Deficiency Payments (Scenario V) were simulated assuming no new technology.

XIV. No New Technology and No Farm Program–All farm program provisions were eliminated (Scenario VII) and the farms were simulated assuming no new technology.

XV. New Entrant and Base Policy–The farm policy provisions of the Base Policy (Scenario I) were simulated assuming the farm operator on the moderate-size farm was a new entrant to farming.

XVI. New Entrant and No Deficiency Payments–

The farm program provisions under No Target Price/Deficiency Payments (Scenario V) were simulated for the moderate-size farm assuming the farm operator was a new entrant to farming.

XVII. New Entrant and No Farm Program—All farm commodity program provisions (Scenario VII) were eliminated for the new entrant on the moderate-size farm during all years of the planning horizon.

Simulation Results

The major findings from the simulation analysis are summarized for the various policy, finance, and technology conditions.

Farm Commodity Program Alternatives

All three representative farms in the Delta Region of Mississippi have a 100% probability of survival over the 10-year period (1983-1992) under the entire range of farm program (and no program) alternatives considered. Further, the probability of the farm operator having a positive after-tax net present value of realized and unrealized financial flows is at or near 100% under the range of farm programs considered. However, in the absence of some or all of the provisions in the current farm commodity program, each of the farms experienced negative annual net farm incomes. Even though they remained solvent over the 10-year planning horizon, these negative net farm incomes portend financial difficulties on each farm over extended periods of time.

Targeting of farm program benefits to farms that produce $300,000 or less in program crops has dramatic economic impact even on the moderate-size (1,443-acre) farm. As a general rule, the very large farm fares the best with the loss of all farm programs because it operates with substantial acreage of leased land, has much less economic incentive to grow in acreage size than the moderate or large farms, and uses more of the retained farm earnings and off-farm income to retire long-term land and intermediate-term machinery debts. The greatest economic incentives to grow in acreage occurred on the moderate-size (1,443-acre) farm for all farm commodity program options considered.

In general, it appears that the two largest farms had captured most of the economies to size available to them, and only the moderate-size farm faced potentials for substantial growth irrespective of the farm commodity policy followed. Continuation of current farm policy but without program payments limitations would provide for the greatest growth of this size farm, with the two largest farms exhibiting only modest increases in farm acreage.

Income Tax Provisions

The reduction in income tax benefits had its major adverse economic impacts for the very large (6,184-acre) farm through a reduction in net farm income of $36,000 annually compared to the Base Farm Policy Scenario (I). The moderate-size (1,443-acre) farm and the large-size (3,119-acre) farm also experienced annual net farm income reductions of $9,000 and $16,500, respectively. The farm operator's average present value of ending net worth on the moderate-size farm under the restrictive income tax provisions was 7% (or some $188,000) less than for the Base Farm Policy Scenario. In contrast, the large and very large farms experienced an increase in ending net worth of some 7% and 8%, respectively, under the restrictive income tax provisions as compared with the Base Farm Policy Scenario.

Each of the three farms failed to grow as rapidly in total acreage under the restrictive income tax provisions as under the Base Farm Policy Scenario, with the greatest impact occurring for the moderate-size and large-size farms. Although, a more restrictive income tax policy would adversely affect each of the three farms in the Delta Region of Mississippi, the impact is rather modest compared to the loss of economic benefits from withdrawing the price or income support payment programs or the entire complement of existing farm commodity programs.

Increased Debt Load, Financial Bailout

Increasing debt loads to a level of 60% (or 64% for the moderate-size farm) of machinery value and 55% of land value resulted in the heaviest economic drag on the very large farm whereby average annual net farm income drops to $3,700. This adverse economic impact results mainly from the much higher land and machinery interest payments as the debt to asset ratios are increased from 36% to 55% for land and from 48% to 60% for machinery. Because of this heavy debt load, the very large farm continues to exhibit low (or negative) average annual net farm income with either a debt restructuring or an interest rate subsidy type of financial bailout.

The interest rate subsidy was the most beneficial of the two alternatives with respect to annual net farm income, particularly for the moderate-size and large-size farms. However, the debt restructuring alternative provided the greatest incentive for additional growth in total acreage, particularly for these two sizes of farms that were in a position to increase their purchases of cropland. In general, the three farms under the higher debt loads would be able to survive and grow in total farm acreage over the 10-year planning period without either of the financial bailout alternatives used in the simulations.

No New Technology

The alternative of having "no new technologies" developed and available for adoption was simulated by holding mean crop yields constant at their 1983 levels, and assuming the distribution of yield on a year-to-year basis experienced during 1974-1983.

Since the yield increases under the "most likely technology" scenarios do have a favorable benefit/cost ratio, the "no new technology" scenarios have the effect of reducing annual net farm incomes on each farm. These reductions were a modest $300 and $4,300 annually on the moderate-size and large-size farms, respectively. However, for the very large farm with a much shorter time lag in adopting new yield-enhancing technology, the impact was to reduce annual net farm income by $26,800. These benefits from new technology were rather modest compared to the benefits from farm commodity price and income support programs. Moreover, the benefits from new technology could largely disappear for even the very large farms should the expected yield increases expand total output in relation to demand sufficiently to reduce cotton and grain prices.

New Entrants into Farming

High land and machinery costs faced by a new entrant on the moderate-size farm adversely impact on the average annual net farm income. Even though the probability of survival over the 10-year period is 100% under the Base Farm Policy (Scenario I), annual net farm income is a negative $18,800, which portends financial difficulty over a longer period of time. This probability of survival drops to 76% when the target price/deficiency payment provisions are withdrawn and to 62% with the loss of all farm commodity programs. Thus, the economic survival of new entrants into farming is particularly dependent on price and income benefits from farm commodity programs (or of some other type of financial assistance). In the absence of such programs, few new farm operators entering farming in the Delta Region of Mississippi would be expected to experience economic success over the next 10 years.

Economic Characteristics of Farms and Nature of the Study

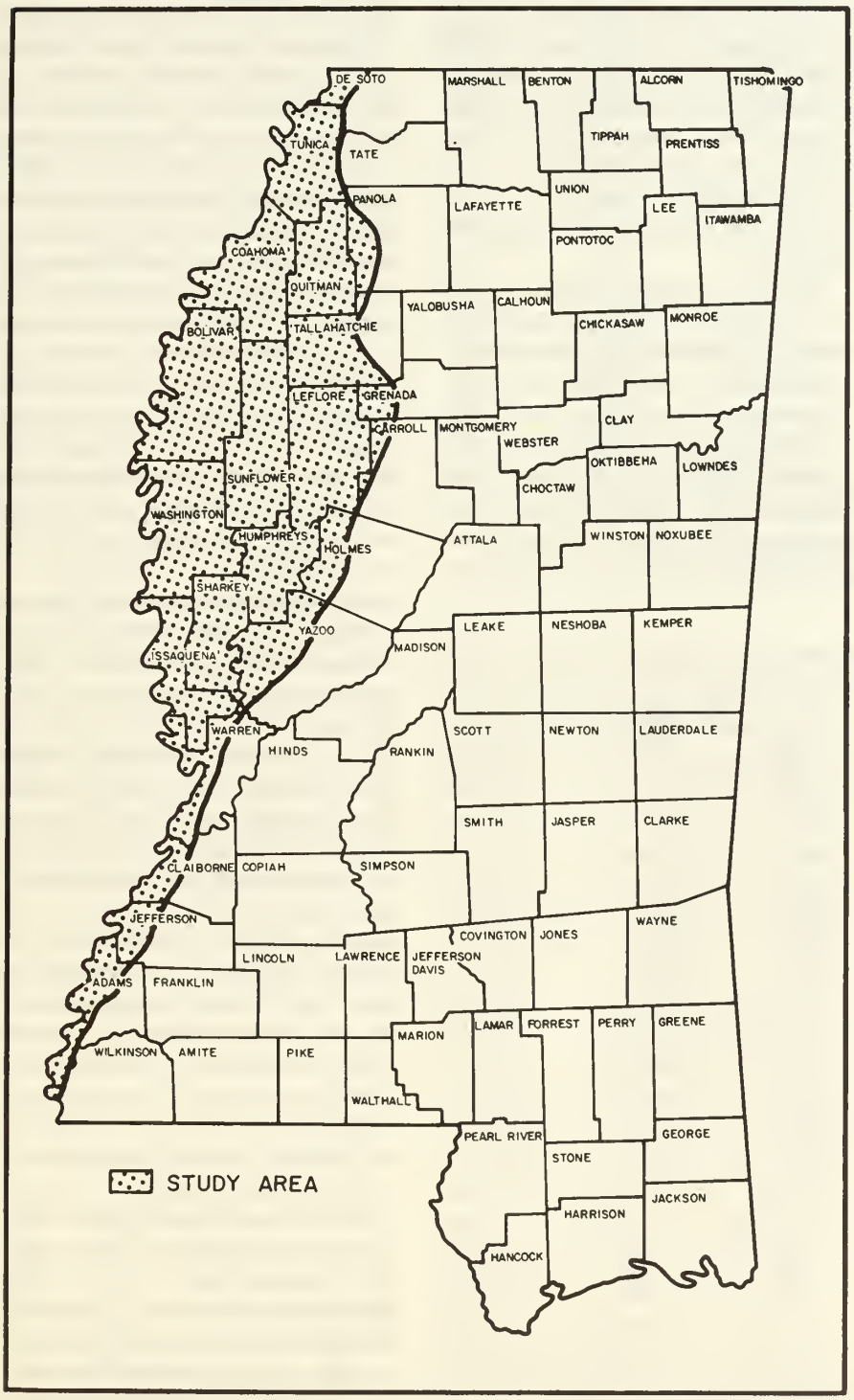

Figure 1. Farm Resources Survey Area in the Delta Region of Mississippi.

Introduction

The purpose of this study was to analyze the impacts of selected farm commodity programs, federal income tax provisions, and farm-level production technologies on the economic viability of representative crop farms in the Delta Region of Mississippi. A number of alternative farm commodity price and income support programs, income tax provisions, and technology scenarios were analyzed with respect to their impacts on the survival and growth of three general crops farms. Each farm produces cotton, rice, soybeans, and wheat. The sizes of farms were selected to represent a moderate, large, and very large farm in the region.

Method of Analysis

Two techniques were used to analyze the effects of the selected farm policy, income tax, and technology provisions. A mail survey was used to obtain information on resource characteristics, acreages devoted to specific crops, and ASCS-reported historic yields of crops receiving payment under current farm program provisions. These data were used to develop resource characteristics of the three representative farms. A whole farm simulation model was used to analyze the effects of alternative farm commodity policy, income tax, finance, and technology advance scenarios on the economic viability and growth characteristics of each farm. The Farm Level Income Tax and Farm Policy Simulator (FLIPSIM V) model

used in the farm simulations is described in detail by Richardson and Nixon (1).

Representative Farms

The mail survey was sent to all farms of 500 acres or more located in the Delta counties of Mississippi in the Fall of 1983 (Figure 1). A total of 116 respondents who produced all four crops on each farm was used in a cumulative frequency distribution analysis to group the farms into three distinct size categories. The "very large" farms approximate the largest 10% of farms from the survey; the "large" farms, the 70th to 90th size percentiles; and the "moderate-size" farms, the lowest 70th percentile of the 116 respondents with farms of 500 acres or more in size.

The three representative farms used for this analysis represent the average characteristics of farms in each size category. A total of 82 farms were in the size category of 500-2,499 acres; 21 farms were in the size category of 2,500-4,499 acres; and the remaining 13 farms were in a size category of 4,500 to slightly more than 10,000 acres. Information on the number of two-wheel and four-wheel drive tractors, combines, cotton pickers, managerial/supervisory workers, secretarial/office workers, shop workers, laborers tractor drivers, acres planted to each crop in 1983 (including PIK acres), etc., was obtained from the mail survey. The three farms developed for this study are a moderate-size farm (1,443 acres); a large farm (3,119 acres); and a very large farm (6,184 acres).

Table 1 provides a summary of the financial and resource characteristics for the three farms. The proportion of cropland owned increases from 37% for the smallest farm to about 50% for the largest farm. The machinery and equipment complement was optimized for the crop acreages on each farm using crop budget performance rates per acre typical of the Delta Region of Mississippi. The market value of machinery and equipment for each farm reflects the 1982 market value of the budgeted machinery complement.

The long-term and intermediate-term debt to asset ratios for the 1,443-acre farm and the 3,119-acre farm were obtained from USDA's 1979 Agricultural Finance Survey (2) and adjusted to reflect the equity levels as reported from the 116 farms responding to the 1983 mail survey. These debt ratios are the average for part-owner general crops farms in the Mississippi Delta Region that had debt on real estate in 1979. Financial ratios for the largest farm were developed by extending the ratios *on a per-acre basis* for a 3,457-acre farm as reported in the 1979 Agricultural Finance Survey and adjusted by the equity levels reported for the largest farm size group in the 1983 mail survey.

Average annual off-farm income adjusted to 1982 levels for the farms was obtained from the 1979 Agricultural Finance Survey. The off-farm income for the very large farm was the average of the amounts reported by eight of the 13 farm operators in this size category obtained through a telephone follow-up interview. Maximum annual family living expenses were assumed to be $27,000 to $45,000, depending on farm size. A marginal propensity to consume disposable income of 0.25 was used, after the minimum family living expense was satisfied, based on USDA estimates of regional consumption functions for the U.S.

Costs of producing the four crops in the Delta Region of Mississippi were estimated by using the Mississippi State University Budget Generator and 1982 prices on all input items. The 1982 annual variable costs of production were assumed to be the same for

Table 1. Financial and resource characteristics for three general crops farms in the Delta Region of Mississippi, 1983

Characteristics	Farm Size (acres)		
	1,443	3,119	6,184
Age of farm operator*	44	44	44
Family size*	4	4	4
Cropland acres owned	533	1,419	3,064
Cropland acres leased	910	1,700	3,120
Acreage of principal crops in 1983			
Cotton	395	1,088	2,250
Rice	305	574	871
Soybeans	640	1,190	2,539
Wheat (or other small grains)	82	247	180
Value of owned cropland ($1,000)	799.5	2,128.5	4,596.0
Value of farm machinery ($1,000)	378.9	786.7	1,209.8
Value of off-farm investments ($1,000)	129.1	210.3	358.7
Beginning cash reserve ($1,000)	31.9	71.1	141.6
Long-term debt ($1,000)	331.4	840.8	1,640.8
Intermediate-term debt ($1,000)	243.8	413.0	574.7
Net worth ($1,000)	748.6	1,921.5	4,047.5
Total equity to assets (fraction)	0.56	0.60	0.64
Long-term debt/asset (fraction)	0.41	0.40	0.36
Intermediate-term debt/asset (fraction)	0.64	0.52	0.48
Off-farm income ($1,000)	18.3	18.2	36.0
Minimum family living expense ($1,000)	18.0	24.0	30.0
Maximum family living expense ($1,000)	27.0	36.0	45.0
Marginal propensity to consume (fraction)	0.25	0.25	0.25
Number of full-time hired employees	4	10	19

* Values for the age and family size variables assumed for the purpose of simulating the effects of alternative farm program provisions for the farms.

the three representative farm sizes. Fixed expenses for machinery and equipment vary by farm size as the complement of machinery is different for each farm size.

The mix of acreages planted to each crop changes by farm size, as determined from the 1983 mail survey. In general, the acreage planted to cotton and soybeans increased relative to the acreage planted to rice and wheat as farm size increased. The 1,443-acre farm planted 73% of tillable cropland to cotton and soybeans, while the 3,119-acre and 6,184-acre farm planted 89% and 82%, respectively, of tillable cropland to cotton and soybeans. In the simulations, as the farm was allowed to grow in size to the next largest farm, the proportion of cropland planted to each crop was changed to reflect these relative differences in crop mix.

Table 2. Annual yields and prices for commodities produced on general crops farms in the Delta Region of Mississippi, 1974-1983.

Year	Cotton Lint	Cotton seed*	Rice	Soybeans	Wheat
	(Yield)				
	(lb/A)	(ton/A)	(cwt/A)	(bu/A)	(bu/A)
1974	691	0.54	50.78	21.1	24.9
1975	466	0.36	43.08	27.5	24.2
1976	461	0.36	47.63	23.6	29.8
1977	839	0.65	37.22	24.2	46.1
1978	908	0.70	41.57	24.8	39.5
1979	704	0.55	42.28	34.7	37.5
1980	540	0.42	38.83	17.0	34.1
1981	616	0.48	43.32	24.5	48.3
1982	1117	0.87	41.28	30.6	45.3
1983	657	0.51	41.47	21.6	40.4
	(Price)**				
	($/lb)	($/ton)	($/cwt)	($/bu)	($/bu)
1974	0.500	97.00	10.10	7.51	3.42
1975	0.497	97.00	9.10	4.55	2.62
1976	0.619	110.00	6.56	6.07	3.46
1977	0.528	77.00	8.12	6.25	2.03
1978	0.615	124.00	7.56	6.35	2.90
1979	0.613	134.00	9.81	6.51	4.10
1980	0.769	134.00	10.40	8.25	3.57
1981	0.569	80.00	10.90	6.20	3.19
1982	0.601	61.00	7.60	5.41	3.16
1983	0.661	165.00	8.48	8.06	3.50

* Cottonseed is a linear function of lint yield, averaging 1.55 pounds of seed per pound of lint.

** All prices are average cash prices in the Delta Region of Mississippi for the following months: cotton lint and cottonseed, November; rice, September; soybeans, November; and wheat, June.

Crop Yields and Prices

Crop yields from experimental plots at three locations in the Delta were used with ASCS-reported yields for farm program payments to each of the mail survey respondents to develop a 10-year yield history for the representative farms. No statistically significant differences were found among the yields for each farm size category. Thus, the same historical yield series was used for each representative farm. Estimated actual yields and prices for the representative farms are shown in Table 2.

The yields were used in a trend regression to develop the multivariate empirical probability distribution function described in Table 3. Judgments of the Office of Technology Assessment (OTA) commodity panels (3) regarding crop yield changes over the 1983-1992 period were used with the trend analysis to develop the annual mean yields over the period under the assumption of the most likely technology advances for each crop. Under this set of assumptions, mean cotton lint yields on farms in the Delta Region of Mississippi are expected to increase by 5%, or about 4 pounds per acre, annually through 1992. Rice yields are expected to increase by 9.2%, or about 44 pounds per acre annually, while wheat yields are projected to increase by 26.6%, or about 1.13 bushels per acre, each year. The per acre yield of soybeans is projected to increase by 8.1%, or about 0.23 bushel per acre, annually. These most likely yield advances involve various sets of technologies such as: (1) variety improvement through genetic engineering, photosynthesis enhancement, and plant growth regulators; (2) improved management of crop pests; (3) biological nitrogen fixation and use of chemical fertilizers; (4) soil, water, and crop management improvements; and (5) a host of other techniques, including labor-saving technologies, fuel savings, communications and information management, etc.

The annual deviations from the trend regression for 1974-1983 yields were expressed as a fraction of their respective mean in 1983 and then sorted to develop the deviations presented in Table 3. A similar analysis was carried out to develop the 1983-1992 deviations from mean prices presented in Table 4. The correlations among yields and prices shown in Table 5 were estimated using the deviations about the trend line for annual yields and prices for the 1974-1983 period. All prices were deflated to 1982 levels by the *Index of Prices Paid by Farmers* prior to fitting the trend line.

Capital Costs

Annual interest rates on existing debt for land, machinery, and

Table 3. Annual means and probability distributions for yields used in simulations for general crops farms in the Delta Region of Mississippi.

Year	Cotton Lint	Cotton seed	Rice	Soybeans	Wheat
	ANNUAL MEAN YIELDS				
	(lb/A)	(ton/A)	(cwt/A)	(bu/A)	(bu/A)
1983	699.90	0.54	42.75	24.96	37.01
1984	703.80	0.55	43.19	25.19	38.14
1985	707.80	0.55	43.63	25.42	39.27
1986	711.70	0.55	44.07	25.66	40.41
1987	715.70	0.55	44.51	25.89	41.54
1988	719.60	0.56	44.95	26.12	42.68
1989	723.50	0.56	45.39	26.35	43.82
1990	727.50	0.56	45.83	26.58	44.95
1991	731.40	0.57	46.26	26.81	46.08
1992	735.40	0.57	46.70	27.04	47.21
	DEVIATIONS FROM MEAN YIELDS (FRACTION)*				
1983	-.279	**	-.153	-.326	-.163
1984	-.256	**	-.068	-.155	-.160
1985	-.215	**	-.048	-.134	-.150
1986	-.214	**	-.035	-.043	-.075
1987	-.205	**	-.003	-.030	-.055
1988	-.011	**	.021	-.024	-.015
1989	.140	**	.042	-.004	.028
1990	.250	**	.053	.118	.095
1991	.314	**	.074	.210	.165
1992	.477	**	.116	.388	.330

* Deviations from a simple trend regression for 1974–1983 data expressed as a fraction of their respective means in 1983 and then sorted to develop the deviations shown.

** Cottonseed is perfectly correlated to lint inside the model.

Table 4. Annual means and probability distributions for prices used in simulations for general crops farms in the Delta Region of Mississippi.

Year	Cotton Lint	Cotton seed	Rice	Soybeans	Wheat
	ANNUAL MEAN PRICES*				
	($/lb)	($/ton)	($/cwt)	($/bu)	($/bu)
1983	0.69	111.75	10.14	6.66	3.95
1984	0.67	109.07	9.74	6.49	3.48
1985	0.65	106.47	9.50	6.34	3.39
1986	0.65	106.47	9.50	6.34	3.39
1987	0.65	106.47	9.50	6.34	3.39
1988	0.65	106.47	9.50	6.34	3.39
1989	0.65	106.47	9.50	6.34	3.39
1990	0.65	106.47	9.50	6.34	3.39
1991	0.65	106.47	9.50	6.34	3.39
1992	0.65	106.47	9.50	6.34	3.39
	DEVIATIONS FROM MEAN PRICES (FRACTION)**				
1983	-.164	-.490	-.360	-.409	-.394
1984	-.114	-.381	-.170	-.186	-.180
1985	-.069	-.344	-.104	-.138	-.082
1986	-.056	-.044	-.083	-.061	-.080
1987	-.028	.023	.053	-.048	-.034
1988	-.021	.114	.054	-.008	.025
1989	.047	.149	.060	.004	.099
1990	.084	.239	.098	.180	.161
1991	.151	.256	.151	.244	.233
1992	.171	.478	.302	.421	.251

* Prices are expressed in real 1982 dollars.

** Deviations from a simple OLS trend regression for 1974–1983 data expressed as a fraction of their respective means in 1983 and then sorted to develop the deviations shown.

operating loans were 9%, 12.5%, and 15%, respectively. Interest rates for new debts on land were 11.5% annually and refinancing of long-term real estate loans was allowed at interest rates of 13% annually. Similarly, new loans for machinery were at a 13.5% annual interest rate, with refinancing of intermediate-term loans allowed at a 14.5% annual interest rate. Cash reserves were assumed to earn 9.5% and off-farm investments 10% interest annually.

The farms were permitted to grow at the end of each year by leasing cropland, or by purchasing cropland–if the operator had cash available (after meeting all expenses) to cover a 30% down payment for land and a 20% down payment for any additional machinery purchases required to operate the proposed larger farm. Growth in farm size also required hiring of additional labor to operate the larger unit.

Table 5. Correlation of yields and prices for general crops farms in the Delta Region of Mississippi*.

	Cotton lint Yield	Cotton Seed Yield	Rice Yield	Soybean Yield	Wheat Yield	Cotton lint Price	Cottonseed Price	Rice Price	Soybean Price	Wheat Price
Cotton lint yield	1.0	.999	-.166	.374	.523	-.228	-.421	-.154	-.007	-.246
Cottonseed yield		1.0	-.156	.378	-.520	-.231	-.426	-.149	-.003	-.235
Rice yield			1.0	-.023	-.405	-.009	.160	.196	.309	.779
Soybean yield				1.0	.208	-.482	-.213	-.178	-.609	.028
Wheat yield					1.0	-.399	-.604	-.218	-.185	-.616
Cotton lint price						1.0	.637	-.422	.453	.368
Cottonseed price							1.0	.002	.437	.545
Rice price								1.0	.381	.204
Soybean price									1.0	.483
Wheat price										1.0

* The correlation matrix was estimated using deviation about a simple OLS trend line for annual yields and prices, 1974–1983. Prices were deflated to a 1982 = 100 base using the "Index of Prices Paid by Farmers" prior to fitting the trend line.

Policy and Technology Scenarios

The three general crops farms were simulated over a 10-year period (1983-1992) for a total of 14 alternative scenarios. These included seven alternative farm commodity program/income tax provision scenarios, one alternative income tax scenario, three financial stress scenarios, and three alternative technology scenarios. In addition, the moderate-size farm was simulated under the conditions of a new entrant into farming for three alternative farm commodity program/income tax provision scenarios. All assumptions regarding policy values for each scenario were the same for each representative farm to allow comparisons of their impacts on different sized farms. Each scenario is described in detail.

Farm Policy Scenarios

I. Base Policy–The Base Policy Scenario involves continuation through 1992 of both the 1981 Farm Bill and the income tax provisions under the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA). In addition, annual mean crop yields projected under the most likely technology advance alternative (Table 3) were used in the simulations. For this scenario it is assumed the following farm policies were in effect.

(1)The CCC loan program is available to producers for cotton, rice, soybeans, and wheat.

(2) A 3-year indirect farmer owned reserve (FOR) is available for wheat.

(3) An acreage diversion/set aside program is in effect for cotton, rice, and wheat during 1983-1985, using the actual acreage reduction levels and diversion payment rates specified for these years.

(4) A target price-deficiency payment program is available for cotton, rice, and wheat in all years.

(5) The $50,000 payment limitation for deficiency and diversion payments is in effect.

(6) Farms of all sizes are eligible to participate in these farm program provisions.

Values for loan rates, target prices, diversion rates, and diversion payment rates for 1983 and 1984 are set at their actual values expressed in constant 1982 dollars. Values for these variables for 1985 are set at their respective levels announced on or before September 14, 1984 by the Secretary of Agriculture. Loan rates and target prices for 1985 are held constant through 1992. No acreage reduc-

Table 6. National loan rates, target prices and acreage set aside/diversion rates for cotton, rice, wheat, and soybeans, 1977–1985.

Year	Loan rate	Target price	Set aside rate	Diversion	Diversion payment rate
			COTTON		
	($/lb)	($/lb)	(%)	(%)	($/lb)
1977	0.4463	0.4780			
1978	0.4800	0.5200			
1979	0.5023	0.5770			
1980	0.4800	0.5840			
1981	0.5246	0.7087			
1982	0.5708	0.7100	15	0	0.00
1983	0.5500	0.7600	20	5	0.25
1984	0.5500	0.8100	25	0	0.00
1985	0.5500	0.8100	20	5	0.25
			RICE		
	($/cwt)	($/cwt)	(%)	(%)	($/cwt)
1977	6.19	8.25			
1978	6.40	8.53			
1979	6.79	9.05			
1980	7.12	9.49			
1981	8.01	10.68			
1982	8.14	10.85	15	0	0.00
1983	8.14	11.40	15	5	
1984	8.00	11.90	20	5	0.00
1985	8.00	11.90	20	15	3.50
			WHEAT		
	($/bu)	($/bu)	(%)	(%)	($/bu)
1977	2.25	2.90			
1978	2.35	3.40			
1979	2.50	3.40			
1980	3.30	3.63			
1981	3.50	3.81			
1982	4.00[a]	4.05	15	0	0.00
1983	3.65	4.30	15	5	2.70
1984	3.30	4.38	20	10	2.70
1985	3.30	4.38	20	10	2.70
			SOYBEANS[b]		
	($/bu)				
1977	3.50				
1078	4.50				
1979	4.50				
1980	5.02				
1981	5.02				
1982	5.02				
1983	5.02				
1984	5.02				
1985	5.02				

[a] Farmer Owned Reserve entry price in 1982 exceeded the $3.55/bu. loan rate for wheat.
[b] Soybeans have been under a loan program only with no target price/deficiency payment program or acreage set aside/diversion provisions.

tion program was assumed to be in effect after 1985. Historical national loan rates, target prices (except for soybeans), acreage set aside/diversion rates, and diversion payment rates for program compliance over the 1977-1985 period are presented in Table 6. All dollar values in Table 6 are expressed in current dollars. The average relationship between real loan rates and real prices for 1977-1982 was computed for each commodity and used to estimate the real average annual prices shown in Table 4 that were used in the 1983-1992 simulations. (This was done to minimize the bias caused by setting mean prices too close to either the loan rate or the target price.) The loan rates and target prices, expressed in constant 1982 dollars and adjusted for grade and quality factors for the Delta Region of Mississippi, are presented in Table 7.

It was assumed the following options for depreciating machinery and calculating income taxes are used for the Base Policy Scenario.

(1) Machinery, livestock, and buildings placed in use prior to 1981 are depreciated using the double declining balance method.
(2) Machinery, livestock, and buildings placed in use after 1980 are depreciated using an accelerated cost recovery method.
(3) The farm operator elects to claim first year expensing for all depreciable items placed into use after 1980.
(4) The farm operator elects to take maximum investment tax credit (ITC) and thus reduce the basis for all depreciable assets placed in service after 1980.
(5) The farm operator adjusts crop sales across tax years to reduce current year taxes.
(6) The farm operator may use either the regular income tax computation or income averaging to calculate federal income tax liabilities.
(7) There is no maximum interest deduction for calculating taxable income.
(8) The actual self employment tax rates and maximum income levels subject to this tax for 1983 and 1984 are used. Announced values for these variables in 1985-1986 were used and the 1986 values were held constant through 1992.
(9) The farm operator elects to trade in old machinery on new replacements at the end of each item's economic life.

II. A 20% Acreage Reduction–The provisions of the Base Policy Scenario were modified by adding a 15% set aside with a 5% diversion for cotton, rice, and wheat in 1986-1992. Normal slippage of 70% for each of the crop and program participation rates were used to estimate the resulting real increase in mean prices for these crops in 1986-1992. All other provisions of the Base Policy Scenario were used without change.

III. No Farm Progarm Payment Limitation–All provisions of the Base Policy Scenario were used except that the $50,000 limitation on diversion and deficiency payments was removed.

IV. No Price Supports and No Diversion Payments–The CCC loan, FOR, and target price provisions under the Base Policy Scenario were assumed to have been eliminated for all years in the 1983-1992 planning horizon. Annual mean prices for all crops were decreased based on the new expected value of their respective probability distributions. Relative variability in prices about their means was increased based on the work of Morton, Devadoss, and Heady (4) as to the effects of no farm program on U.S. agriculture. Since all other provisions of the Base Policy Scenario were left intact, the acreage diversion and set aside programs in place for 1983-1985 were assumed to remain in effect.

V. No Target Price/Deficiency Payment–The target price and deficiency payment program was assumed to be eliminated for all years of the 1983-1992 planning horizon. All other provisions of the Base Policy Scenario were used without change.

VI. Target Farm Program Benefits–All farm program and income tax provisions of the Base Policy Scenario were used except that farms producing more than $300,000 of program commodities (cotton, rice, soybeans, and wheat) valued at their localized loan rate

Table 7. Localized loan rates and target prices for a general crops farm in the Delta Region of Mississippi*.

	Cotton lint		Rice		Soybeans	Wheat	
Year	Loan rate	Target price	Loan rate	Target price	Loan rate	Loan rate	Target price
	($/lb)	($/lb)	($/cwt)	($/cwt)	($/bu)	($/bu)	($/bu)
1983	0.55	0.75	8.54	11.97	4.89	3.53	3.92
1984	0.53	0.78	8.21	12.20	4.77	3.11	4.06
1985	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1986	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1987	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1988	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1989	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1990	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1991	0.52	0.76	8.00	11.91	4.66	3.03	4.03
1992	0.52	0.76	8.00	11.91	4.66	3.03	4.03

* Loan rates and target prices in effect for 1983–1984 and announced for 1985 were deflated to 1982 real dollars. These values were localized for the typical grade or quality of crop marketed in the Delta Region of Mississippi in 1982–1983.

were not permitted to participate directly in the program provisions (CCC loan, FOR, target price/deficiency payments, and set aside-diversions). Mean prices and relative variability in prices were not adjusted because sufficient numbers of farms with less than $300,000 of program commodity sales were assumed to participate in the farm program for the price support provisions of the CCC loan and FOR to function normally.

VII. No Farm Program—All farm program provisions outlined for the Base Policy Scenario were eliminated for all 10 years of the planning horizon. Mean annual prices and relative variance in prices for the No Price Supports and No Diversion Payments Scenario (IV) were used due to eliminating provisions of the CCC loan and FOR reserve under this scenario.

Income Tax Scenario

VIII. Reduced Income Tax Benefits and Base Policy Program—The federal income tax provisions in place for the Base Policy Scenario were made more restrictive. All farm policy provisions of the Base Policy Scenario were left unchanged. The more restrictive federal income tax provisions included:

(1) Machinery, livestock, and buildings were depreciated using the straight line cost recovery method.
(2) First year expensing provisions were eliminated for all depreciable items.
(3) Maximum investment tax credit (ITC) provisions were eliminated.
(4) The maximum annual interest expense which could be used to reduce taxable income was $15,600.
(5) The farm operator must sell obsolete machinery upon disposition rather than trading it in on new replacements, thus forcing recapture of excess depreciation deductions.

All other federal income tax provisions for the Base Policy Scenario were used as outlined earlier.

Financial Stress Scenarios

IX. Base Finance Scenario—Each farm's long-term debt to asset ratio was increased to 0.55 and its intermediate-term debt to asset ratio was increased to 0.60 to represent a highly leveraged farm. (If the farm's intermediate-term debt to asset ratio exceeded 0.60 based on the 1979 Ag Finance Survey, the greater value was used.) Annual long-term and intermediate-term interest rates were increased to their average values (0.1139 and 0.1343, respectively) for 1980-1983 to represent a farm which had been forced to refinance its assets during the past 4 years. These same interest rates were used for all three financial stress scenarios. The farm program provisions associated with the Base Policy Scenario were used for all three financial stress scenarios.

X. Debt Restructure—The length of intermediate-term loans was increased by 1 year to 7 years, and a portion of intermediate debt was converted to long-term debt. The conversion of intermediate-term debt to long-term debt was not permitted to increase the long-term debt to asset ratio above 0.65. For each of the representative farms, this constraint substantially restricted debt conversion. Annual interest rates, total debt loads, and farm program provisions were the same as those used for the Base Finance Scenario (IX).

XI. Interest Subsidy—The annual interest rates, debt levels, and farm program provisions in the Base Finance Scenario (IX) were simulated, but an interest subsidy was provided during the first 2 years. The interest subsidy took the form of an interest rate reduction equal to 3.4 percentage points for long-term interest rates and 5.4 percentage points for intermediate-term interest rates. These interest rate reductions were the amounts necessary to reduce their respective interest rates (0.1137 and 0.1343) to a 4% real rate assuming a 4% annual inflation rate.

No New Technology Scenarios

XII. No New Technology and Base Farm Policy—The federal income tax and farm program provisions in the Base Policy Scenario (I) were simulated assuming that no new technology would be introduced during the 1983-1992 period. For the Delta Region of Mississippi, mean annual yields were not expected to increase in the absence of any new technology being developed and adopted. Without new technology, existing knowledge and techniques would be adequate to only maintain the yield levels already achieved in the region. Thus, the mean annual yields for 1974-1983 were used in all three of the "No New Technology" scenarios. For these scenarios, mean yields for each year through 1992 for cotton, soybeans, wheat, and rice were those shown for 1983 in Table 3. Since the simulation analysis was stochastic, however, the actual yields (and prices) were drawn randomly (within the simulation model) from the sample of yields presented in the historical data (1974-1983) in Table 2.

XIII. No New Technology and No Deficiency Payments—The farm program provisions in the No Target Price/Deficiency Payments Scenario (V) were simulated assuming mean annual crop yields used in the No New Technology and Base Policy Scenario (XII).

XIV. No New Technology and No Farm Program—All farm program provisions were eliminated (Scenario VII) and mean annual crop yields used in the No New Technology and Base Farm Policy Scenario (XII) were used.

New Entrant Scenarios

XV. New Entrant and Base Farm Policy–The farm policy provisions of the Base Policy Scenario (I) were evaluated assuming the farm operator on the moderate-size farm was a new entrant. The farm operator was assumed to have the minimum equity in land (30%) and farm machinery (35%). All farm machinery was considered to have a 1982 new machinery cost. Annual interest rates for long-term and intermediate term loans were set at the average 1980-1983 interest rates. No off-farm investments or off-farm income were allowed. These assumptions regarding the farm operator's initial debt-asset position and sources of income were used for all three new entrant scenarios.

The farm operator was assumed to be purchasing 533 acres of cropland and leasing 910 acres. Because the farm operator was paying the full cost of all inputs (land, capital, machinery, and labor) this scenario provides an indication of the long-run survivability of the moderate-size farm under conditions of continuing the current farm policy and income tax provisions and conditions of the most likely technology advance scenarios.

XVI. New Entrant and No Deficiency Payments–The farm program provisions in the No Target Price/Deficiency Payments Scenario (V) were simulated under the conditions that the farm operator was a new entrant to farming.

XVII. New Entrant and No Farm Program–All farm commodity program provisions as in Scenario VII were eliminated during all years of the planning horizon for this scenario.

Evaluation Criterion

The FLIPSIM V model provides considerable detail as to the economic viability of a representative farm at the end of each iteration, e.g., ending leverage ratio, ending net worth, ending farm size, total assets, total debt, net present value, and whether or not the farm remained solvent for 10 years. By repeating each scenario for 50 iterations, the model generates the information necessary to estimate the probability distributions for key output variables. The means of these key output distributions are used to compare the economic impacts of selected policy and technology scenarios for each farm. The following output variables for the model were used to assess the impacts of the scenarios described in the previous section.

(1) Probability of survival–Defined as the probability that the farm will remain solvent for 10 years. It is the probability that the farm operator would maintain at least the minimum financial ratios (30% equity in land and 35% equity in farm machinery) for each of the 10 years of the planning horizon.

(2) Probability of a positive net present value–The probability that the farm will have a positive after-tax net present value. An after-tax, real discount rate of 3% was used to calculate the farm's net present value. With a 4% annual inflation rate, this is equivalent to a 7% nominal discount rate. This statistic indicates the probability that at least a 3% real rate of return is earned on the operator's initial net worth.

(3) After-tax net present value (NPV)–The present value of the operator's annual cash withdrawals (CW) plus the present value of the change in net worth (NW) minus the present value of annual off-farm income (OY):

$$NPV = \sum_{t=1}^{T} \frac{CW_t - OY_t}{(1.03)^t} + \frac{NW_T}{(1.03)^T} - NW_o$$

Cash withdrawals (CW) equal family living expenses plus state and federal income taxes and self-employment taxes. Initial net worth (NW_o) and ending new worth (NW_T) explicitly consider the value of off-farm investments and accrued taxes. A 3% after-tax, real discount rate was used to calculate net present value for each of the farms.

(4) Present value of ending net worth–Indicates the change in the real net worth of the farm over the planning horizon. Net worth is affected by increases or decreases in the value of land and machinery assets and by retained earnings. This value can be compared directly to the initial net worth of the farm given in Table 1 to indicate the relative magnitude of real financial growth.

(5) Acres owned, leased, and controlled at the end of the planning horizon–For each iteration these statistics indicate the impacts of the alternative scenarios on growth in land resources for the farms. These three statistics provide an indication of how the farm increased acreage, either by purchasing or leasing land. Also, they indicate whether the farm was forced to sell cropland to remain solvent.

(6) Total long-term and intermediate-term debts at the end of the planning horizon–The two measures provide an insight into the financial stress of the farm over the planning horizon. Increases in average ending debt from one scenario to another can be due to either rapid growth through purchasing land and machinery or the farm operator being forced to refinance large cash flow deficits. When surplus cash is available, the operator is permitted to first prepay intermediate-term debts and then prepay new long-term debts. Therefore, large ending intermediate-term debts indicate insufficient cash was available to reduce intermediate-term debt through prepayment of principal.

(7) Ending equity ratio–The

farm's ending ratio of total net worth to total assets. This ratio provides a "bottom-line" measure for comparing the farm's ending financial position across scenarios.

(8) Internal rate of return–For each farm, this measure is calculated at the end of each iteration. The internal rate of return is the discount rate which makes the present value of the operator's annual cash withdrawals and change in net worth equal zero. The variables previously outlined for the net present value formula are used to calculate internal rate of return.

(9) Average annual net farm income–The net farm income received by the farm operator averaged over all years simulated. Net farm income equals total farm receipts plus total government payments minus all cash production expenses, interest payments, labor costs, fixed costs (excluding principal payments), and depreciation. This value excludes all nonfarm income and interest earned on cash reserves.

(10) Average annual government payment–The annual government payments (deficiency and diversion payments) to the farm operator averaged over all years simulated.

Results from the Simulations

Farm Commodity Policy and Income Tax Alternatives

The results from simulating the effects of the seven alternative farm commodity policy scenarios and the alternate income tax provisions for the three farms in the Delta Region of Mississippi are presented in Tables 8, 9, and 10. Under the provisions of these eight policy alternatives, each farm had a 100% probability of survival in that equity in land and machinery did not fall below 30% and 35%, respectively. One of the principal reasons for the solvency of these farms over the 10-year planning horizon was the availability of off-farm income to meet some of the cash flow needs.

Each of the farms exhibited a very high probability (98% to 100%) of having a positive after-tax net present value under all policy scenarios involving eligibility for government program payments. Only the policy scenario with no farm income or price support (Scenario VII) for the 1,443-acre farm, and the policy scenarios with no target prices and deficiency payments (Scenario V) or targeting of farm program benefits to farms producing less than $300,000 in program crops (Scenario VI) for the 6,184-acre farm, exhibited a probability of having a positive after-tax net present value below 100% (Tables 8-10).

The remaining criteria in Tables 8-10 are indicative of farm size, wealth, and financial characteristics that are projected to occur on these farms over the 10-year simulation under each policy alternative. Rates of change (expressed as percentages from initial levels) in the values of these variables are presented in Table 11 for each of the farms.

The present value of ending net worth is one measure of real wealth accumulation. In interpreting these values in Table 11, two revealing features are

Table 8. Comparison of selected farm commodity and income tax policy scenarios for a 1,443-acre general crop farm in the Delta Region of Mississippi.

Criteria	Initial Situation	Alternative Scenarios*							
		I	II	III	IV	V	VI	VII	VIII
Probability of survival (%)	--	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	--	100	100	100	100	100	100	98	100
After-tax net present value ($1,000)	--	1,090.3	1,188.4	1,408.7	383.7	425.1	335.6	346.6	1,203.9
Average present value of ending net worth ($1,000)	748.6	1,650.8	1,757.3	1,880.7	1,105.5	1,134.0	1,058.7	1,069.7	1,532.9
Average ending cropland owned (acres)	533.0	651.4	709.0	801.8	533.0	539.4	533.0	533.0	555.4
Average ending cropland leased (acres)	910.0	1,358.0	1,348.4	1,290.8	1,092.4	1,105.2	1,047.6	1,057.2	1,358.0
Average ending cropland controlled (acres)	1,443.0	2,009.4	2,057.4	2,092.6	1,625.4	1,644.6	1,580.6	1,590.2	1,913.4
Average ending long-term debts ($1,000)	331.4	218.7	270.5	354.5	135.3	123.9	154.3	170.7	130.8
Average ending intermediate-term debts ($1,000)	243.8	40.2	63.1	36.8	89.7	90.4	101.5	91.1	13.0
Average ending equity ratio (fraction)	0.56	0.88	0.86	0.83	0.86	0.87	0.84	0.84	0.89
Average internal rate of return (fraction)	--	0.11	0.11	0.13	0.05	0.06	0.05	0.05	0.13
Average annual net farm income ($1,000)	--	38.9	40.4	64.6	-14.2	-6.9	-16.3	-17.6	29.9
Average annual government payments ($1,000)	--	48.2	45.2	75.4	1.9	1.9	1.9	0.0	47.9

* The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Diversion Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

noticeable. First, as one compares the eight policy scenarios for each size of farm, substantial greater growth in real net worth occurs on the farms under conditions that continue current farm commodity policy and income tax provisions with and without acreage reductions and farm program payments limitations (Scenario I-III) and with a more restrictive set of income tax provisions (Scenario VIII). For the 1,443-acre farm, real net worth increases by some 105% to 151% under these program alternatives. The largest rate of growth in real net worth (a 151% increase from the initial situation) occurs for the alternative that continues the 1981 Farm Bill provisions, but with no farm program payments limitations (Scenario III). A policy that continues the current farm program, but with a 20% acreage reduction in 1986-1992, results in a 135% growth in real net worth. Much lower growth rates in real net worth occur for the policy alternatives that elminate various provisions of the current farm program, withdraw all farm program support, or target the benefits to farms producing less than $300,000 of program crops. Similar patterns are evident in the effects of the policy alternatives on rates of growth in real net worth of the 3,119-acre farm and the 6,184-acre farm.

The second noticeable pattern in Table 11 is the decline in the growth rate in real wealth as the size of the farm increases from the 1,443-acre farm to the 6,184-acre farm for each of the policy alternatives. Comparisons among the different farm sizes must be made with caution because the initial total equity to asset ratios differ. However, the results indicate that the policy alternatives involving farm program payments (Scenarios I-III and Scenario VIII) induced a greater growth rate in real wealth on the moderate-size farm as compared with the two larger farms.

This pattern of growth is even more evident when one examines changes in farm acreage. The 1,443-acre farm experienced considerable growth in both owned land acreage and/or acreage leased under Scenarios I-III and Scenario VIII. In contrast, the two larger farms exhibited less than 7%

Table 9. Comparison of selected farm commodity and income tax policy scenarios for a 3,119-acre general crop farm in the Delta Region of Mississippi.

Criteria	Initial Situation	Alternative Scenarios*							
		I	II	III	IV	V	VI	VII	VIII
Probability of survival (%)	--	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	--	100	100	100	100	100	100	100	100
After-tax net present value ($1,000)	--	1,232.8	1,645.4	3,146.0	656.0	731.3	592.1	620.1	2,070.8
Average present value of ending net worth ($1,000)	1,921.5	2,940.1	3,279.8	4,418.0	2,482.2	2,537.4	2,432.5	2,453.7	3,138.8
Average ending cropland owned (acres)	1,419.0	1,431.8	1,451.0	1,777.4	1,419.0	1,425.4	1,419.0	1,419.0	1,419.0
Average ending cropland leased (acres)	1,700.0	1,895.2	1,888.8	2,100.0	1,700.0	1,709.6	1,700.0	1,700.0	1,716.0
Average ending cropland controlled (acres)	3,119.0	3,327.0	3,339.8	3,877.4	3,119.0	3,135.0	3,119.0	3,119.0	3,135.0
Average ending long-term debts ($1,000)	840.8	134.0	137.0	342.1	191.3	157.8	197.7	218.7	273.8
Average ending intermediate-term debts ($1,000)	413.0	255.3	189.2	5.2	251.8	276.8	279.7	252.1	225.9
Average ending equity ratio (fraction)	0.60	0.89	0.90	0.89	0.87	0.87	0.86	0.87	0.85
Average internal rate of return (fraction)	--	0.07	0.08	0.12	0.04	0.05	0.04	0.04	0.10
Average annual net farm income ($1,000)	--	38.3	65.1	148.0	-20.6	-8.2	-28.9	-25.1	21.8
Average annual government payments ($1,000)	--	49.9	49.1	160.6	4.7	4.8	0.0	0.0	49.9

* The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986–1992.
III -- No Farm Program Payment Limitation in 1983–1992.
IV -- No Price Support and No Diversion Payment in 1983–1992.
V -- No Target Price/Deficiency Payment in 1983–1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983–1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

growth in farm size under these scenarios, with the exception of the 3,119-acre farm under Scenario III wherein payments limitations are removed. The 1,443-acre farm experienced a 10% to 14% increase in acreage, whereas the two larger farms exhibited virtually no growth in farm acreage for the policy alternatives involving elimination of some or all the program payments provisions and when program payments are targeted to farms with less than $300,000 of program commodity sales. These results indicate that farm program payments are an important inducement to growth of moderate-size general crops farms in the Delta Region of Mississippi.

The two largest farms reduced a substantial portion of the long-term real estate debt under all scenarios. The 1,443-acre farm had a much lower rate of long-term debt payback, principally because growth in farm size occurred through purchase of additional cropland under Scenarios I-III, and the use of accumulated cash to purchase machinery and equipment for expansion on leased land under Scenarios IV-VIII. The 1,443-acre farm generally exhibited a larger liquidation of its intermediate-term debt than the two larger farms for each of the policy alternatives. Each of the farms tended to use income from both farm and non-farm sources to pay back existing debts, and the ratio of total equity to total assets increased appreciably on each farm for all of the policy alternatives.

The three general crops farms in the Delta Region of Mississippi are much very dependent on farm program payments in maintaining net farm income. This dependency is revealed in Tables 8, 9, and 10. When one examines the average annual net farm incomes and average annual total government program payments over the 10 years, the policy alternatives involving relatively little or no government payments (Scenarios IV-VII) resulted in negative average annual net farm incomes.

Summary of Results

All three farms had a 100% chance of remaining solvent (i.e., equity levels in land and machinery remained above 30%

Table 10. Comparison of selected farm commodity and income tax policy scenarios for a 6,184-acre general crop farm in the Delta Region of Mississippi.

Criteria	Initial Situation	Alternative Scenarios*							
		I	II	III	IV	V	VI	VII	VIII
Probability of survival (%)	--	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	--	100	100	100	100	98	98	100	100
After-tax net present value ($1,000)	--	1,619.6	2,465.4	4,742.5	1,182.6	1,267.8	966.9	1,108.9	3,139.4
Average present value of ending net worth ($1,000)	4,047.5	5,449.6	6,116.2	7,728.0	5,135.0	5,175.2	4,964.2	5,078.9	5,901.6
Average ending cropland owned (acres)	3,064.0	3,121.6	3,112.0	3,294.4	3,092.8	3,102.4	3,096.0	3,102.4	3,076.8
Average ending cropland leased (acres)	3,120.0	3,126.4	3,142.4	3,235.2	3,177.6	3,142.4	3,145.6	3,164.8	3,126.4
Average ending cropland controlled (acres)	6,184.0	6,248.0	6,254.4	6,529.6	6,270.4	6,244.8	6,241.6	6,267.2	6,203.2
Average ending long-term debts ($1,000)	1,640.8	106.4	57.3	110.9	144.2	129.0	173.5	227.0	261.0
Average ending intermediate-term debts ($1,000)	574.7	456.4	381.9	120.0	383.3	466.0	465.0	409.2	354.5
Average ending equity ratio (fraction)	0.64	0.91	0.92	0.94	0.91	0.91	0.90	0.90	0.89
Average internal rate of return (fraction)	--	0.05	0.06	0.10	0.04	0.04	0.04	0.04	0.08
Average annual net farm income ($1,000)	--	41.9	118.2	277.1	-19.7	-0.6	-42.9	-32.4	5.9
Average annual government payments ($1,000)	--	49.8	49.8	278.0	7.9	0.0	0.0	0.0	49.9

* The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986–1992.
III -- No Farm Program Payment Limitation in 1983–1992.
IV -- No Price Support and No Diversion Payment in 1983–1992.
V -- No Target Price/Deficiency Payment in 1983–1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983–1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

Table 11. Rates of change in selected farm size, wealth and financial characteristics under alternative farm commodity and income tax policy scenarios for general crops farms in the Delta Region of Mississippi.

Criteria	Initial Situation	Percentage change in variable level from initial situation for alternative scenarios*							
		I	II	III	IV	V	VI	VII	VIII
		1,443-acre farm							
Present value of ending net worth ($1,000)	748.6	120	135	151	48	51	41	43	105
Cropland owned after 10 years (acres)	533.0	22	33	50	0	1	0	0	4
Cropland leased after 10 years (acres)	910.0	49	48	42	20	21	15	16	49
Total cropland controlled after 10 years (acres)	1,443.0	39	43	45	13	14	10	10	33
Total long-term debts after 10 years ($1,000)	331.4	-34	-18	7	-59	-63	-53	-48	-61
Total intermediate-term debts after 10 years ($1,000)	243.8	-84	-74	-85	-63	-63	-58	-63	-95
Total equity to asset ratio after 10 years (%)**	56.0	88	86	83	86	87	84	84	89
		3,119-acre farm							
Present value of ending net worth ($1,000)	1,921.5	53	70	130	29	32	27	28	63
Cropland owned after 10 years (acres)	1,419.0	1	2	25	0	<1	0	0	0
Cropland leased after 10 years (acres)	1,700.0	11	11	24	0	<1	0	0	1
Total cropland controlled after 10 years (acres)	3,119.0	7	7	24	0	<1	0	0	<1
Total long-term debts after 10 years ($1,000)	840.8	-84	-84	-59	-77	-81	-76	-74	-67
Total intermediate-term debts after 10 years ($1,000)	413.0	-38	-54	-99	-39	-33	-32	-40	-45
Total equity to asset ratio after 10 years (%)**	60.0	89	90	89	87	87	86	87	85
		6,184-acre farm							
Present value of ending net worth ($1,000)	4,047.5	35	51	91	27	28	23	25	46
Cropland owned after 10 years (acres)	3,064.0	2	2	8	<1	1	1	1	<1
Cropland leased after 10 years (acres)	3,120.0	<1	<1	4	2	<1	<1	1	<1
Total cropland controlled after 10 years (acres)	6,184.0	1	1	6	1	<1	<1	1	<1
Total long-term debts after 10 years ($1,000)	1,640.8	-93	-96	-93	-91	-92	-89	-86	-84
Total intermediate-term debts after 10 years ($1,000)	547.7	-21	-34	-79	-33	-19	-19	-29	-38
Total equity to asset ratio after 10 years (%)**	64.0	91	92	94	91	91	90	90	89

* The scenarios are:

I -- Continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986–1992.
III -- No Farm Program Payment Limitation in 1983–1992.
IV -- No Price Support and No Diversion Payment in 1983–1992.
V -- No Target Price/Deficiency Payment in 1983–1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983–1992.
VIII -- Reduced Income Tax Benefits and continuation of the 1981 Farm Bill.

** Values for all policy scenarios represent the percent equity in total assets after 10 years not the percentage changes in these equity to asset ratios.

and 35%, respectively) over the 10-year planning horizon.

The probability of having a positive after-tax net present value over the 10 years was 100% for the 1,443-acre farm and for the 3,119-acre farm for all policy alternatives involving farm program government payments. However, the probability of having a positive net present value over the 10 years was 98% on the 6,184-acre farm for the No Target Price/Deficiency Payment Scenario (V) and the policy involving targeting of farm program benefits to farms with less than $300,000 of program crops (Scenario VI).

Real ending net worth increased substantially (from 105% to 151%) for the 1,443-acre farm for the policy alternatives involving current farm program payments. Increases in real net worth occurred on the two larger farms under these policy alternatives, but at much lower rates of growth.

Policy alternatives involving farm program payments influence the growth in both acreage owned and leased on the 1,443-acre farm. Some growth in farm acreage occurred for this farm under the policy alternatives that eliminated or restricted farm program payments.

The 3,119-acre farm and the 6,184-acre farm experienced little or no growth in farm acreage under the policy alternatives that restricted or eliminated farm program payments.

The two largest farms reduced initial real estate debts substantially under all the policy alternatives considered. Payback occurred under these policy alternatives for the 1,443-acre farm, but at rates considerably less than those for the two larger farms.

The 1,443-acre farm generally paid back less of its initial real estate debt under the policy alternatives because expansion of farm size involved some purchase of additional cropland and purchase of additional machinery and equipment for expansion through leasing of cropland.

The two largest farms generally liquidated a smaller portion of intermediate-term debts than long-term debts under each of the policy alternatives.

The ratio of total equity to assets increased appreciable on each farm under each of the policy alternatives. This ratio increased by 27 to 33 percentage points from an initial level of 56% on the 1,443-acre farm; it increased by 25 to 30 percentage points from an initial level of 60% on the 3,119-acre farm; and by 25 to 30 percentage points from an initial level of 64% on the 6,184-acre farm.

Each of the farms is very dependent on farm program payments in maintaining reasonable levels of net farm income (i.e., returns to owned land, general farm overhead, and management and risk).

Stimulus to growth in real net worth and farm acreage is greatest for the 1,443-acre farm under provisions of current farm policy and income tax regulations. The results indicate that moderate-size farms are likely to expand to large-size farms but little expansion is likely to occur on farms that are already large.

Failure to maintain effective program payment limitations or removal of payment limitations substantially increase net farm income on each farm; but such program provisions would be expected to result in relatively large government program payment outlays to farm producers represented by these three general crops farms.

Financial Bailout Strategies

Two farm credit policy alternatives were considered for assisting highly leveraged farmers remain solvent. The first was a debt restructuring policy whereby intermediate-term debt was refinanced and the repayment period was lengthened. To simulate the effects of such a credit policy, the financial position of the three general crops farms in the Delta Region of Mississippi were modified to depict highly leveraged farms. The long-term debt to asset ratio for each farm was increased to 55%, the intermediate-term debt to asset ratios were set equal to 60% (or 64% in the case of the 1,443-acre farm), and annual interest rates on old loans were increased to their average values for 1980-1983 (11.37% for long-term and 13.4% for intermediate-term loans).

A second credit alternative was to provide the farm operators of the highly leveraged farms with an interest rate reduction (subsidy) to offset the effects of high real interest rates. To compare the effects of these two financial bailout alternatives, the three farms were simulated under conditions of continuing the 1981 Farm Bill provisions but with the higher debt to asset ratios and the higher interest rates on long-term and intermediate-term loans (Scenario IX). Then the length of the intermediate-term loans was increased by 1 year to 7 years, and a portion of intermediate-term debt was converted to long-term debt provided the long-term debt to asset ratio did not exceed 65% (Scenario X). The annual interest rates, total debt loads, and farm program provisions were the same as those used for the Base Finance Scenario (IX).

The second financial bailout alternative was simulated under the provisions of the Base Finance Scenario (IX), but with an interest subsidy provided during the first 2 years of the 10-year simulation period (Scenario XI). The interest subsidy was in the form of an interest rate reduction of 3.37 percentage points for long-term interest rates and 5.4 percentage

points for intermediate-term interest rates. These interest rate reductions were the amounts necessary to reduce long-term interest (11.37%) and intermediate-term interest (13.4%) to a 4% real interest rate, assuming a 4% annual inflation rate.

The results from simulating the effects of these financial bailout alternatives on the highly leveraged farms are presented in Table 12. All three farms exhibited a 100% probability of survival and a 100% probability of having a positive after-tax net present value over the 10-year planning horizon for each of the scenarios. Average net present value for the farm operator and average present value of ending net worth were greatest under the debt restructuring alternative (Scenario X) for each of the farms.

Real wealth increased on each farm for the three alternative scenarios. The 1,443-acre farm again exhibited the largest rates of growth in net worth (ranging from 135% for Scenario XI to 152% for Scenario X) as shown in Table 13.

Each of the farms grew in acreage with the 1,443-acre farm having the largest rates of growth and the 6,184-acre farm exhibiting the slowest rates of growth. Long-term debts increased on each farm under Scenario X because farm growth came about through substantial cropland purchases. The 3,119-acre farm and the 6,184-acre farm had much smaller increases in cropland purchases (and in leased land) under the policy of an interest rate subsidy (Scenario XI). Consequently, the long-term debt on these two farms was reduced under Scenario XI. A substantial portion of the intermediate-term debt was repaid for each farm under Scenarios IX and XI as compared to Scenario X, because increased investment in machinery and equipment is required to operate the relatively larger farm under Scenario X. Only about half of the intermediate-term debt was paid back on each of the farms under the debt restructuring scenario. Consequently, the ratio of total equity to assets increased the least under this debt restructure policy alternative when compared with the Base Financial Scenario (IX) or the Interest Subsidy Scenario (XI).

Summary of Results

All three farms had a 100% chance of remaining solvent and having a positive after-tax net present value over the 10-year planning horizon for each financial bailout alternative.

Average net present value and present value of ending net worth increased substantially on each farm with the largest rate of

Table 12. Comparison of selected financial bailout scenarios * for the general crops farms in the Delta Region of Mississippi.

Criteria	Alternative Scenarios for the 1,443-acre farm			Alternative Scenarios for the 3,119-acre farm			Alternative Scenarios for the 6,184-acre farm		
	IX	X	XI	IX	X	XI	IX	X	XI
Probability of survival (%)	100	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	100	100	100	100	100	100	100	100	100
After-tax net present value ($1,000)	1,097.2	1,178.5	1,080.9	1,918.4	2,103.5	1,656.5	2,386.1	2,955.0	2,119.1
Average present value of ending net worth ($1,000)	1,563.2	1,655.7	1,545.1	3,237.2	3,430.6	2,967.7	5,259.0	5,839.7	4,989.6
Average ending cropland owned (acres)	817.8	910.6	766.6	1,870.2	2,318.2	1,627.0	3,390.4	4,244.8	3,275.2
Average ending cropland leased (acres)	1,290.8	1,204.4	1,258.8	1,975.2	2,400.8	2,058.4	3,216.0	3,411.2	3,177.6
Average ending cropland controlled (acres)	2,108.6	2,115.0	2,025.4	3,845.4	4,719.0	3,685.4	6,606.4	7,656.0	6,452.8
Average ending long-term debts ($1,000)	648.1	840.7	520.5	1,571.4	2,449.9	1,111.5	2,484.4	4,251.9	2,047.4
Average ending intermediate-term debts ($1,000)	35.0	92.5	23.7	97.2	107.1	146.8	334.3	128.1	419.4
Average ending equity ratio (fraction)	0.73	0.68	0.77	0.69	0.61	0.74	0.69	0.61	0.71
Average internal rate of return (fraction)	0.12	0.12	0.11	0.10	0.11	0.09	0.07	0.08	0.06
Average annual net farm income ($1,000)	35.5	29.4	37.7	30.1	20.4	33.8	3.7	-14.8	5.4
Average annual government payments ($1,000)	48.4	48.4	48.3	49.9	49.9	49.9	49.9	49.9	49.9

* The scenarios are:
IX -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X -- Restructure debt for a highly leveraged farm.
XI -- Interest rate subsidy (buy-down) in the first 2 years for a highly leveraged farm.

growth in net worth occurring under the debt restructuring alternative (Scenario X).

Each farm expanded its acreage, both through cropland purchases and leasing of cropland, with the smallest farm (1,443-acre farm) again exhibiting the most rapid rate of growth.

Long-term debt increased on each farm due to cropland purchases, with the exception of the two largest farms under an interest subsidy policy (Scenario XI).

Intermediate-term debt was reduced for each farm under each financial bailout scenario. The moderate-size farm and the large farm reduced intermediate-term debt relatively more than the very large farm under these financial stress conditions.

The highly leveraged general crops farms in the Delta Region of Mississippi exhibit characteristics that indicate survival and growth under financial bailout policies. The implementation of the debt restructuring and interest subsidy policy alternatives would appear to stimulate substantial growth in farm size in this production region.

Impacts of No Technological Advance

Policy Scenarios I-XI were evaluated under the assumption of the most likely technology advance conditions whereby new technology would be introduced during the 1983-1992 period. Yield gains were projected as a result of "new technology" becoming available and being adopted on farms over the planning horizon based on the judgments of the OTA commodity panels.

The farms were simulated for three of the policy scenarios under the assumption that no new technology would become available for the crops over the 1983-1992 planning horizon. Mean crop yields for 1983-1992 were held constant at their historical 1974-1983 mean level. But since the simulations were stochastic, the actual yields were drawn randomly from the sample of yields for the 1974-1983 period. These yields were included for three farm commodity policy scenarios. Scenario XII assumes the Base Farm Policy Scenario (I) but with these lower mean yields; Scenario XIII assumes the "no target price or deficiency payment" situation (Scenario V) with the lower yields

Table 13. Rates of change in selected farm size, wealth, and financial characteristics under alternative financial bailout scenarios* for the general crops farms in the Delta Region of Mississippi.

Criteria	Initial Situation	Percentage change in variable level from initial situation for alternative scenarios		
		IX	X	XI
		1,443-acre farm		
Present value of ending net worth ($1,000)	656.7	138	152	135
Cropland owned after 10 years (acres)	533.0	53	71	44
Cropland leased after 10 years (acres)	910.0	42	32	38
Total cropland controlled after 10 years (acres)	1,443.0	46	47	40
Total long-term debts after 10 years ($1,000)	439.7 (519.7)[a]	47	62	18
Total intermediate-term debt after 10 years ($1,000)	227.3 (147.3)[a]	-84	-37	-90
Total equity to asset ratio after 10 years (%)[b]	49	73	68	77
		3,119-acre farm		
Present value of ending net worth ($1,000)	1,532.6	111	124	94
Cropland owned after 10 years (acres)	1,419.0	32	63	15
Cropland leased after 10 years (acres)	1,700.0	16	41	21
Total cropland controlled after 10 years (acres)	3,119.0	23	51	18
Total long-term debts after 10 years ($1,000)	1,170.7 (1,383.5)[a]	34	77	-5
Total intermediate-term debt after 10 years ($1,000)	472.0 (259.2)[a]	-79	-59	-69
Total equity to asset ratio after 10 years (%)[b]	48	69	61	74
		6,184-acre farm		
Present value of ending net worth ($1,000)	3,009.2	75	94	66
Cropland owned after 10 years (acres)	3,064.0	11	39	7
Cropland leased after 10 years (acres)	3,120.0	3	9	2
Total cropland controlled after 10 years (acres)	6,184.0	7	24	4
Total long-term debts after 10 years ($1,000)	2,527.8 (2,987.4)[a]	-2	42	-19
Total intermediate-term debt after 10 years ($1,000)	725.9 (266.3)[a]	-54	-52	-42
Total equity to asset ratio after 10 years (%)[b]	48	69	61	71

* The scenarios are:
IX -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm
X -- Restructure debt for a highly leveraged farm
XI -- Interest rate subsidy (buy-down) in the first 2 years for a highly leveraged farm

[a] The initial situation was the same for the three financial bailout scenarios, except for the initial long-term and intermediate-term debts under Scenarios X which are given in the parentheses.

[b] Values for all scenarios represent the percent equity in total assets after 10 years not the percentage changes in these equity to asset ratios.

and Scenario XIV assumes the "no farm program" situation (Scenario VII), again with lower yields.

The results from the simulations are presented in Table 14. The "no new technology" scenarios had little effect on the probability of having a positive after-tax net present value on each farm. They reduced slightly the probability (to 96% and 98% for the 3,119-acre farm and the 6,184-acre farm, respectively) under the policy of No Farm Program (Scenario XIV). These probabilities of having a positive after-tax net present value did not change from the most likely technology situation on the 1,443-acre farm. The impacts of these modest technology-driven yield increases on product prices were not evaluated. Consequently, in the Base Farm Policy Scenario (XII), the moderate-size and large-size farms show small improvement in annual net farm income as a result of technological advance. The very large farm shows a substantial increase in net farm income since the technology adoption rate was much faster on this size of farm.

Table 15 provides a comparison of the rates of change from the initial situation in the farm acreage, wealth, and farm financial variables assuming no change in technology and the most likely technology advance for the three policy alternatives. The present value of the farm operator's ending net worth increased at a slightly faster rate on each of the farms under the "most likely technology" scenarios than under the "no new technology" scenarios. The rate of increase was much higher for the Base Farm Policy scenarios (Scenarios I and XII), than for the other farm commodity policy scenarios for each of the farms.

The results in Table 15 show that the rates of growth in cropland purchases, leasing, and total farm acreage were almost identical under the two technology situations for a given farm. However, the 1,443-acre farm exhibited substantially higher growth rates in farm acreage than the two larger farms. Also, the rates of payback on long-term and intermediate-term loans under the two technology situations were near identical for a given farm.

These results indicate that the most likely technology changes projected for the Delta Region of Mississippi are expected to have the greatest impact on growth in real wealth and farm acreage of the 1,443-acre farm. The 3,119-acre farm and the 6,184-acre farm are expected to exhibit little growth in farm acreage over the 10-year simulation period. The economic impact expected from new technology is rather minimal com-

Table 14. Comparison of selected farm policy alternatives assuming no new technology changes for the general crops farms in the Delta Region of Mississippi.

Criteria	Alternative scenarios* for the 1,443-acre farm			Alternative scenarios* for the 3,119-acre farm			Alternative scenarios* for the 6,184-acre farm		
	XII	XIII	XIV	XII	XIII	XIV	XII	XIII	XIV
Probability of survival (%)	100	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	100	100	98	100	100	96	100	100	98
After-tax net present value ($1,000)	1,052.8	394.0	319.6	1,066.0	640.0	514.5	1,396.3	945.9	695.5
Average present value of ending net worth ($1,000)	1,613.1	1,103.5	1,043.0	2,785.7	2,450.8	2,354.4	5,286.4	4,915.2	4,714.5
Average ending cropland owned (acres)	648.2	536.2	533.0	1,428.6	1,422.2	1,419.0	3,185.6	3,144.0	3,131.2
Average ending cropland leased (acres)	1,358.0	1,102.0	1,054.0	1,914.4	1,725.6	1,700.0	3,136.0	3,132.8	3,129.6
Average ending cropland controlled (acres)	2,006.0	1,638.2	1,587.0	3,343.0	3,147.8	3,119.0	6,321.6	6,276.8	6,260.8
Average ending long-term debts ($1,000)	215.7	124.2	181.1	136.4	204.9	303.4	286.5	293.6	415.4
Average ending intermediate-term debts ($1,000)	40.7	90.6	92.9	255.7	259.2	244.5	429.6	443.9	413.5
Average ending equity ratio (fraction)	0.88	0.86	0.83	0.89	0.87	0.84	0.89	0.89	0.88
Average internal rate of return (fraction)	0.11	0.06	0.05	0.06	0.04	0.04	0.04	0.04	0.03
Average annual net farm income ($1,000)	38.6	-7.3	-18.3	34.0	-11.9	-29.9	15.1	-27.5	-57.7
Average annual government payments ($1,000)	48.2	1.9	0.0	49.9	4.8	0.0	49.9	7.9	0.0

* The scenarios are:
XII -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions, assuming no new technology scenario.
XIII -- No Target Price/Deficiency Payment program in 1983–1992, assuming no new technology scenario.
XIV -- No Farm Program in 1983–1992, assuming no new technology scenario.

pared with the economic impact from changing the farm commodity price and income support programs.

New Entrant into Farming

The simulation results for the alternative farm commodity policies assumed that the farms were operated by established farm operators. These simulations provide indications of the impacts of the alternative farm policies in the relative short-run. They do not provide information on the survivability and economic viability of potentially new entrants into farming.

To obtain some indication of the long-run effects of selected farm policies, the 1,443-acre farm was analyzed for three farm policy scenarios (I, V, and VII) assuming the most likely technology advance scenarios and assuming that the farm operator was a new entrant in farming.

The entering farm operator was assumed to have minimum equity in farmland (30%) and farm machinery (35%), and all farm machinery was considered to have a 1982 new machinery cost. Annual interest rates for current long-term loans and intermediate-term loans were set equal to the average interest rates for 1980-1983 (11.37% and 13.4%, respectively). The farm operator was assumed to be purchasing 533 acres of cropland and leasing 910 acres for a total of 1,443 acres.

The results from the simulations for a new entrant under the three policy scenarios are provided in Table 16. Under the Base Policy Scenario XV (continuation of the 1981 Farm Bill), the new entrant had a 100% chance of remaining solvent for 10 years, and the operator had a 100% probability of having a positive after-tax net present value. Net worth increased by 98% over the 10-year period, and the farm grew by 27% in total cropland acreage controlled after

Table 15. Rates of change in selected farm size, wealth, and financial characteristics under selected farm policy and technological advance alternatives for the general crops farms in the Delta Region of Mississippi.

Criteria	Initial Situation	Percentage change in variable level from initial situation for alternative scenarios*					
		Assuming most likely technology			Assuming no new technology		
		I	V	VII	XII	XIII	XIV
	----------1,443-ACRE FARM----------						
Present value of ending net worth ($1,000)	748.6	120	51	43	115	47	39
Cropland owned after 10 years (acres)	533.0	22	1	0	22	<1	0
Cropland leased after 10 years (acres)	910.0	49	21	16	49	21	16
Total cropland controlled after 10 years (acres)	1,443.0	39	14	10	39	14	10
Total long-term debts after 10 years ($1,000)	331.4	-34	-63	-48	-34	-62	-45
Total intermediate-term debt after 10 years ($1,000)	243.8	-84	-63	-63	-83	-63	-62
Total equity to asset ratio after 10 years (%)[a]	56.0	88	87	84	88	86	83
	----------3,119-ACRE FARM----------						
Present value of ending net worth ($1,000)	1,921.5	53	32	28	45	28	23
Cropland owned after 10 years (acres)	1,419.0	1	<1	0	<1	<1	0
Cropland leased after 10 years (acres)	1,700.0	11	<1	0	13	2	0
Total cropland controlled after 10 years (acres)	3,119.0	7	<1	0	7	<1	0
Total long-term debts after 10 years ($1,000)	840.8	-84	-81	-74	-84	-76	-64
Total intermediate-term debt after 10 years ($1,000)	413.0	-38	-33	-40	-38	-37	-41
Total equity to asset ratio after 10 years (%)[a]	60.0	89	87	87	89	87	84
	----------6,184-ACRE FARM----------						
Present value of ending net worth ($1,000)	4,047.5	35	28	25	31	21	16
Cropland owned after 10 years (acres)	3,064.0	2	1	1	4	3	2
Cropland leased after 10 years (acres)	3,120.0	<1	<1	1	<1	<1	<1
Total cropland controlled after 10 years (acres)	6,184.0	1	<1	1	2	2	1
Total long-term debts after 10 years ($1,000)	1,640.8	-93	-92	-86	-83	-82	-75
Total intermediate-term debt after 10 years ($1,000)	574.7	-21	-19	-29	-25	-23	-28
Total equity to asset ratio after 10 years (%)[a]	64.0	91	91	90	89	89	88

* The scenarios are:

I -- Continuation of the 1981 Farm Bill and 1983 federal tax provision, with most likely technology advance scenario.

V -- No Target Price/Deficiency Payment in 1983–1992, with most likely technology advance scenario.

VII -- No Farm Program in 1983–1992, with most likely technology advance scenario.

XII -- Continuation of the 1981 Farm Bill and 1983 federal tax provision with no new technology scenario.

XIII -- No Target Price/Deficiency Payment in 1983–1992, with no new technology scenario.

XIV -- No Farm Program in 1983–1992, with no new technology scenario.

[a] Values for all scenarios represent the percent equity in total assets after 10 years not the percentage change in these equity to asset ratios.

10 years. Much of the growth in farm acreage resulted from leasing additional cropland (31% increase) with some increase in purchased acreage (19%). Long-term debt increased 42%, while almost all (91%) of the intermediate-term debt was paid back. The total equity to asset ratio increased from the initial situation of 33% to an ending situation of 61% after the 10 years.

When the Target Price/Deficiency Payment Program Scenario (XVI) or the No Farm Program Scenario (XVII) alternatives were considered the probability of the farm operator remaining solvent dropped to 76% and 62%, respectively. The mean value for after-tax net present value was negative for the no farm program option. Owned cropland acreage decreased 53% under Scenario XVI and 51% under Scenario XVII as the new entrant was forced to sell off cropland in an attempt to remain solvent. Long-term debts were reduced by around 40% from their initial levels, while about half of the intermediate-term loans were repaid. The farm remained in operation an average of 9 years under Scenario XVI, and an average of 8 years under the No Farm Program Scenario (XVII).

Because the entering farm operator started with minimum equity in land and new farm machinery, full costs of using these resources were incurred. The relative low probabilities of survival for Scenarios XVI and XVII indicate the dependency of new entrants on an income and price support program. These results indicate that as long as resources remain valued at current levels in Delta Region of Mississippi agriculture, the industry will continue to depreciate out current investment and few new operators will enter farming in the absence of farm commodity price and income support programs.

As a practical matter, a new entrant into the region's agriculture with low equity can probably only survive by using mainly one or more of the following strategies: (1) by leasing land and/or machinery; (2) by achieving much higher than average crop yields; and/or (3) by arranging financing that postpones a part of the initial liability for principal and/or interest payments. The net farm incomes for Scenarios XVI and XVII are negative in large amounts (Table 16). Thus, even the successful implementation of these strategies is not likely to ensure successful establishment of this new entrant in farming for extended periods of time.

Table 16. Comparison of selected farm policy alternatives for a new entrant on the 1,443-acre general crops farm in the Delta Region of Mississippi.

Criteria	Initial Situation	Alternative Scenarios*			Percentage change from initial situation*		
		XV	XVI	XVII	XV	XVI	XVII
Probability of survival (%)	--	100	76	62	--	--	--
Probability of a positive after-tax net present value (%)	--	100	70	58	--	--	--
After-tax net present value ($1,000)	--	629.8	57.2	-35.7	--	--	--
Present value of ending net worth ($1,000)	498.3	984.9	395.4	319.0	98	-21	-36
Cropland owned after 10 years (acres)	533.0	636.4	249.2	260.4	19	-53	-51
Cropland leased after 10 years (acres)	910.0	1,193.8	1,209.8	1,182.6	31	33	30
Total cropland controlled after 10 years (acres)	1,443.0	1,830.2	1,459.0	1,443.0	27	1	0
Total long-term debts after 10 years ($1,000)	519.7	737.3	299.9	306.3	42	-42	-41
Total intermediate-term debts after 10 years ($1,000)	471.1	41.0	200.6	248.4	-91	-57	-47
Total equity to assets after 10 years (fraction)	0.33	0.61	0.51	0.47	--	--	--
Internal rate of return after 10 years (fraction)	--	0.11	0.00	-0.07	--	--	--
Average annual net farm income ($1,000)	--	-18.8	-76.8	-91.3	--	--	--
Average annual government payments ($1,000)	--	47.3	2.3	0.0	--	--	--

* The scenarios are:
XV -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions
XVI -- No Target Price/Deficiency Payment Program for 1983-1992
XVII -- No Farm Program in 1983-1992

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Economic analysis of stale seedbed concept of soybean production on clay soil

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Economic Analysis of Stale Seedbed Concept of Soybean Production on Clay Soil

Introduction

The lower Mississippi River alluvial flood plain occupies about 20 million acres from the Boot Heel of Missouri to New Orleans, Louisiana. About 9.3 million acres of this area consist of shrinking-swelling clayey soils. Previous research (Heatherly, 1981; Barrentine and Tupper, 1983) has shown that these soils require little or no primary tillage (subsoiling, chisel plowing, or deep disking) for soybean production. In fact, recent findings (Heatherly and Elmore, 1983) have shown that a "stale" or weathered seedbed can be used for planting soybeans in these soils, and the timeliness of planting achieved with this concept, in combination with irrigation during the full reproductive cycle, will achieve maximum seed yield (Heatherly, 1984).

Economic analysis (Salassi et al., 1984) has shown that properly timed irrigation of soybeans grown on soils of the Delta can result in increased returns to land, management, and general farm overhead. The objective of research reported in this bulletin was to determine if the stale seedbed concept for planting soybeans on clay soil, in combination with irrigation during reproductive development, will result in greater net return to the grower.

A thorough understanding of just what comprises the stale seedbed concept is necessary before a proper evaluation of its worth can be made.

The stale seedbed concept is geared toward avoiding delays in planting soybeans on clay soils. These soils give up water very slowly, and thus do not support rapid vegetative growth that is seen on the coarser-textured soils of the Delta (Heatherly and Russell, 1979). Therefore, use of a stale seedbed can aid in utilizing as much growing season as possible in order to realize optimum plant growth. Conservation of soil and fossil fuel resources is inherent in the process.

There are no set steps to follow, nor is there a specific order that must be adhered to. The following points describe the theory and general methodology which make up the concept.

(1) The shrinking-swelling clay, silty clay, and clay loam soils do not require tillage from a physical standpoint; that is, they do not have hardpans, etc., that only tillage can remedy. Therefore, tillage should be used only for weed control and smoothing of the soil surface.

(2) Following soybean harvest, a field may be disked to smooth the soil surface or remove old rows. A preplant incorporated (PPI) grass herbicide can be applied at this time if land does not flood. If the area is not tilled in the fall, then these operations can be performed in late winter or early spring. The idea is to ensure that enough time remains between the tillage and intended planting time to allow the seedbed to weather and become smooth.

(3) The tillage described in (2) is not necessary unless combine ruts are present or a PPI herbicide must be applied for grass control. The availability of postemergence herbicides for grass control reduces dependence on the PPI materials. If there are no combine ruts, and/or a PPI herbicide will not be applied, the present year's soybean crop can be planted in last year's old rows with no tillage.

(4) The clay soils are usually too wet in the early spring for chiseling or disking. A tractor irreparably ruts the field if any type of tillage operation is attempted. However, a planter with double-disk openers can be used without prior tillage, and any ruts created by the tractor tires during planting will be in the row middles and should present no problem. In fact, they provide a natural furrow for drainage or furrow irrigation. Therefore, these soils can be planted before any other operations can be performed on them. Excellent control of planting depth is achieved in the smooth, noncloddy seedbed.

(5) At planting, existing vegetation must be removed. This can be done with a variety of individual chemicals or combinations of chemicals applied at or near planting. Residual herbicides can also be applied.

(6) There are indications that the weed spectrum may change with continued use of this limited tillage system. Therefore, the weed control options, both tillage and chemical methods, should remain flexible on a year-to-year basis. This system should not be considered practical in fields where perennial weeds, such as Johnsongrass, are a recurring problem. Also, adequate surface drainage is a necessity.

Methodology

Agronomic. The specific production inputs for each year are outlined in previous reports (Heatherly, 1984; Heatherly and Elmore, 1986). Soybeans were

planted in the untilled, stale seedbed between May 11 and May 17 of 1979 through 1982. At this time, areas assigned the conventionally prepared seedbed treatment were disked to kill existing vegetation. This tillage created a cloddy seedbed that was not suitable for planting until a subsequent rainfall. Planting of these areas was necessarily delayed until late May or early June. These later plantings each year were preceded by a disk and/or springtooth harrow for seedbed preparation. Bedford, a Group V (early) variety, and Bragg or Braxton, Group VII (late) varieties, were planted each year at a rate of 10 seeds per foot of 40-inch row.

Weeds present in the untilled seedbed of the mid-May plantings were killed with a tank mix of either linuron or metribuzin plus dinoseb applied broadcast immediately after planting. The 1980, 1981, and 1982 study areas received a disk-incorporated application of trifluralin in either November, January, or February. The conventional seedbed plantings had linuron or metribuzin applied to them immediately after planting. All plantings received cultivation plus postemergence applications of over-the-top or post-directed herbicides as needed for control of weeds throughout the growing season.

Irrigation treatment each year was either nonirrigated (NI) or irrigated (I), with irrigation started at beginning of bloom and continued for the remainder of the growing season. Water was applied by the furrow method whenever soil water potential at the 12-inch soil depth dropped to between -50 and -100 centibars. All plots were harvested when they matured, and yields were converted to 13% seed moisture content.

Economic. Production practices represent actual practices applied by treatment. Estimated costs of production practices and materials used in each treatment were obtained from annual budget publications issued by the Department of Agricultural Economics, Mississippi State University and Mississippi Agricultural and Forestry Experiment Station (Parvin et al., 1979, 1980, 1981; Hamill, 1982), and represent estimated annual production costs associated with the respective treatments (Appendix Tables 1-8). Irrigation costs represent estimated costs of using a gated pipe system to apply the respective amounts of irrigation water to each treatment and variety as indicated in Appendix Table 9. Irrigation costs do not include land forming costs which should be considered if land forming is necessary. Estimated costs of a gated pipe system are presented in Appendix Table 10.

Seed yield was measured for each treatment and variety combination (Appendix Table 11). Soybean prices used in this report were the seasonal average received for the year as reported by the Mississippi Crop and Livestock Reporting Service (Appendix Table 12). Annual budgets were prepared for the nonirrigated and irrigated treatments and variety combinations of each year. Based on these budgets, estimated costs and returns were developed (Tables 1-4).

Table 1. Seed yield and estimated costs and returns of irrigated (I) and nonirrigated (NI) soybeans planted in stale and conventionally tilled seedbeds on Sharkey clay at Stoneville, MS in 1979.

		Stale seedbed				Conventional seedbed			
		Bedford		Bragg		Bedford		Bragg	
Item	Unit	NI	I	NI	I	NI	I	NI	I
Seed yield	bu/acre	50.90	48.50	55.20	58.10	47.40	41.60	54.30	55.10
Price[1]	$/bu	6.37	6.37	6.37	6.37	6.37	6.37	6.37	6.37
Gross revenue	$/acre	324.23	308.95	351.62	370.35	301.94	264.99	345.89	350.99
Estimated direct costs									
Production costs[2]	$/acre	42.04	42.04	42.04	42.04	37.67	37.67	37.67	37.67
Irrigation costs[3]	$/acre	0.00	21.90	0.00	17.49	0.00	21.17	0.00	18.52
TOTAL	$/acre	42.04	63.94	42.04	59.53	37.67	58.84	37.67	56.19
Return above direct costs	$/acre	282.19	245.01	309.58	310.57	264.27	206.15	308.22	294.80
Estimated fixed costs									
Production costs[4]	$/acre	11.84	11.84	11.84	11.84	13.50	13.50	13.50	13.50
Irrigation costs[5]	$/acre	0.00	24.44	0.00	24.44	0.00	24.44	0.00	24.44
TOTAL	$/acre	11.84	36.28	11.84	36.28	13.50	37.94	13.50	37.94
Total specified costs	$/acre	53.88	100.22	53.88	95.81	51.17	96.78	51.17	94.13
Return to land, management, and general farm overhead	$/acre	270.35	208.73	297.74	274.29	250.77	168.21	294.72	256.86

[1] Seasonal average price received in 1979 (Appendix Table 12).
[2] Itemized in Appendix Tables 1 and 2.
[3] Estimated direct costs per acre inch of water (Appendix Table 10) multiplied by the amount of water applied (Appendix Table 9).
[4] See Appendix Tables 1 ($53.88–$42.04 = $11.84) and 2 ($51.17–$37.67 = $13.50).
[5] See Appendix Table 10.

Table 2. Seed yield and estimated costs and returns of irrigated (I) and nonirrigated (NI) soybeans planted in stale and conventionally tilled seedbeds on Sharkey clay at Stoneville, MS in 1980.

		Stale seedbed				Conventional seedbed			
		Bedford		Bragg		Bedford		Bragg	
Item	Unit	NI	I	NI	I	NI	I	NI	I
Seed yield	bu/acre	14.70	40.60	19.80	52.40	17.20	46.80	22.60	44.30
Price[1]	$/bu	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75
Gross revenue	$/acre	113.93	314.65	153.45	406.10	133.30	362.70	175.15	343.33
Estimated direct costs									
Production costs[2]	$/acre	55.91	55.91	55.91	55.91	61.87	61.87	61.87	61.87
Irrigation costs[3]	$/acre	0.00	61.45	0.00	79.82	0.00	56.15	0.00	54.10
TOTAL	$/acre	55.91	117.39	55.91	135.73	61.87	118.02	61.87	115.97
Return above direct costs	$/acre	58.02	197.26	97.54	270.37	71.43	244.68	113.28	227.36
Estimated fixed costs									
Production costs[4]	$/acre	17.04	17.04	17.04	17.04	22.25	22.25	22.25	22.25
Irrigation costs[5]	$/acre	0.00	24.44	0.00	24.44	0.00	24.44	0.00	24.44
TOTAL	$/acre	17.04	41.48	17.04	41.48	22.25	46.69	22.25	46.69
Total specified costs	$/acre	72.95	158.87	72.95	177.21	84.12	164.71	84.12	162.66
Return to land, management, and general farm overhead	$/acre	40.98	155.78	80.50	228.89	49.18	197.99	91.03	180.67

[1] Seasonal average price received in 1980 (Appendix Table 12).
[2] Itemized in Appendix Tables 3 and 4.
[3] Estimated direct costs per acre inch of water (Appendix Table 10) multiplied by the amount of water applied (Appendix Table 9).
[4] See Appendix Tables 3 ($72.95–$55.91 = $17.04) and 4 ($84.12–$61.87 = $22.25).
[5] See Appendix Table 10.

Table 3. Seed yield and estimated costs and returns of irrigated (I) and nonirrigated (NI) soybeans planted in stale and conventionally tilled seedbeds on Sharkey clay at Stoneville, MS in 1981.

		Stale seedbed				Conventional seedbed			
		Bedford		Braxton		Bedford		Braxton	
Item	Unit	NI	I	NI	I	NI	I	NI	I
Seed yield	bu/acre	14.60	41.30	15.30	48.70	15.60	35.30	25.20	43.70
Price[1]	$/bu	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Gross revenue	$/acre	91.25	258.13	95.63	304.38	97.50	220.63	157.50	273.13
Estimated direct costs									
Production costs[2]	$/acre	56.67	56.67	56.67	56.67	58.94	58.94	58.94	58.94
Irrigation costs[3]	$/acre	0.00	37.19	0.00	48.66	0.00	22.64	0.00	33.96
TOTAL	$/acre	56.67	93.86	56.67	105.33	58.94	81.58	58.94	92.90
Return above direct costs	$/acre	34.58	164.27	38.96	199.05	38.56	139.05	98.56	180.23
Estimated fixed costs									
Production costs[4]	$/acre	21.51	21.51	21.51	21.51	26.07	26.07	26.07	26.07
Irrigation costs[5]	$/acre	0.00	24.44	0.00	24.44	0.00	24.44	0.00	24.44
TOTAL	$/acre	21.51	45.95	21.51	45.95	26.07	50.51	26.07	50.51
Total specified costs	$/acre	78.18	139.81	78.18	151.28	85.01	132.09	85.01	143.41
Return to land, management, and general farm overhead	$/acre	13.07	118.32	17.45	153.10	12.49	88.54	72.49	129.72

[1] Seasonal average price received in 1981 (Appendix Table 12).
[2] Itemized in Appendix Tables 5 and 6.
[3] Estimated direct costs per acre inch of water (Appendix Table 10) multiplied by the amount of water applied (Appendix Table 9).
[4] See Appendix Tables 5 ($78.18–$56.67 = $21.51) and 6 ($85.01–$58.94 = $26.07).
[5] See Appendix Table 10.

Table 4. Seed yield and estimated costs and returns of irrigated (I) and nonirrigated (NI) soybeans planted in stale and conventionally tilled seedbeds on Sharkey clay at Stoneville, MS in 1982.

		Stale seedbed				Conventional seedbed			
		Bedford		Braxton		Bedford		Braxton	
Item	Unit	NI	I	NI	I	NI	I	NI	I
Seed yield	bu/acre	14.50	33.40	15.00	40.40	13.10	24.80	17.60	34.90
Price[1]	$/bu	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55
Gross revenue	$/acre	80.48	185.37	83.25	224.22	72.71	137.64	97.68	193.70
Estimated direct costs									
Production costs[2]	$/acre	46.32	46.32	46.32	46.32	52.93	52.93	52.93	52.93
Irrigation costs[3]	$/acre	0.00	33.96	0.00	45.28	0.00	33.96	0.00	33.96
TOTAL	$/acre	46.32	80.28	46.32	91.60	52.93	86.89	52.93	86.89
Return above direct costs	$/acre	34.16	105.09	36.93	132.62	19.78	50.75	44.75	106.81
Estimated fixed costs									
Production costs[4]	$/acre	23.66	23.66	23.66	23.66	33.06	33.06	33.06	33.06
Irrigation costs[5]	$/acre	0.00	24.44	0.00	24.44	0.00	24.44	0.00	24.44
TOTAL	$/acre	23.66	48.10	23.66	48.10	33.06	57.50	33.06	57.50
Total specified costs	$/acre	69.98	128.38	69.98	139.70	85.99	144.39	85.99	144.39
Return to land, management, and general farm overhead	$/acre	10.50	56.99	13.27	84.52	(13.28)[6]	(6.75)	11.69	49.31

[1] Seasonal average price received in 1982 (Appendix Table 12).
[2] Itemized in Appendix Tables 7 and 8.
[3] Estimated direct costs per acre inch of water (Appendix Table 10) multiplied by the amount of water applied (Appendix Table 9).
[4] See Appendix Tables 7 ($69.98–$46.32 = $23.66) and 8 ($85.99–$52.93 = $33.06).
[5] See Appendix Table 10.
[6] Numbers in parentheses indicate a net loss.

Weather Summary

Moderate temperatures and frequent rainfall characterized the 1979 growing season (Table 5). Only 14 days (14%) of the June 11 to Sept. 20 period had maximum temperatures of 95°F or greater, and the longest consecutive period at this level was the July 1 to July 6 period when all varieties were still in vegetative development. The longest period without significant rainfall (>0.5-inch) during May through August was 13 days. No significant rainfall fell from Sept. 5 through Sept. 20, which corresponded to the podfill period of Bragg.

In 1980, a majority of the days (76%) in the June 11 to Sept. 20 period had a maximum temperature of 95°F or greater, and the maximum exceeded 100°F on 30 days (38%) from June 30 to Sept. 16. Between June 30 and July 18 (bloom period of Bedford), all daily temperatures went above 100°F. These extremely high temperatures, coupled with the low 3.1 inches of rain that fell between July 1 and Sept. 30, created an extreme moisture deficit condition during most of the 1980 growing season.

In 1981, 44 (43%) of the days between June 11 and Sept. 20 had maximum temperatures of 95° or greater, but only 4% had maximums of 100°F or greater. Between June 30 and July 30, the period when all varieties had at least started blooming, only 13 days had temperatures exceeding 95°F. The remainder of the days with these temperatures were split about evenly between the vegetative periods and the postbloom periods. The July 1 to Aug. 30 period received 5.3 inches of evenly distributed rainfall, and this brought periods of cooler days

Table 5. Total rainfall and average maximum temperature for 10- or 11-day intervals from May 1 to Sept. 30, 1979–1982, at Stoneville, MS.

	Rainfall (inches)				Temperature (°F)			
Period	1979	1980	1981	1982	1979	1980	1981	1982
May 1–10	3.78	0.70	0.88	0.15	79	77	77	79
May 11–20	0.85	4.02	3.09	0.35	82	80	76	87
May 21–31	3.27	1.18	0.64	1.19	79	84	85	91
June 1–10	1.05	0.00	2.81	0.68	86	86	88	91
June 11–20	0.34	0.52	0.06	2.04	92	93	94	86
June 21–30	2.24	1.91	0.00	3.00	88	94	94	88
July 1–10	1.78	0.00	2.02	0.00	94	102	88	94
July 11–20	1.11	0.68	0.24	0.00	91	103	96	96
July 21–31	3.52	1.09	0.82	1.74	92	92	94	93
Aug. 1–10	0.68	0.30	0.42	0.00	93	97	95	92
Aug. 11–20	1.16	0.09	0.88	1.18	90	98	92	91
Aug. 21–31	1.12	0.98	0.91	0.35	90	94	92	95
Sept. 1–10	2.21	0.00	1.70	0.31	87	96	84	89
Sept. 11–20	0.08	0.00	1.95	2.28	80	96	81	88
Sept. 21–31	3.38	4.51	0.00	0.00	82	78	90	78

interspersed among the days with high maximum temperatures. The longest period with no significant rainfall (>0.5-inch) was the June 7 to June 30 period, when all varieties were still vegetative and had adequate soil moisture for growth.

The June 11 to Sept. 20 period of 1982 had only 32 days (31%) with temperature maximums of 95°F or greater; however, 18 of these fell between June 30 and July 30, the period when all varieties had at least started to bloom. Most of the remainder occurred during the last days of August when all varieties were in the seed-filling stage. The July 1 to July 26, July 31 to Aug. 14, and Aug. 16 to Sept. 2 periods of 1982 all received no significant rainfall (>0.5 inch) and the total for the July 1 to Aug. 30 period was only 3.3 inches.

Results

Yields, production and irrigation costs, and estimated returns for each method of seedbed treatment for irrigated and nonirrigated soybeans are presented in Tables 1-4. Yield data are from plots of each treatment and variety in each of the 4 years (Appendix Table 11). The differences in annual estimated costs for each treatment are due to differences in the amounts of irrigation water applied in a given year. Differences in annual returns are attributed to different yields and irrigation costs associated with the method of seedbed treatment and variety, and irrigation vs. nonirrigation of a treatment.

Estimated returns above direct costs for each variety in each year are summarized in Table 6. Average returns above direct costs for the stale seedbed plantings of Bedford that were irrigated were more than $17 per acre higher ($177.91 vs. $160.16) than from the conventional seedbed plantings that were irrigated. When the data from the extremely hot and dry year of 1980 are eliminated, the irrigated stale seedbed plantings of Bedford averaged $39.48 more than the irrigated conventional plantings. In 1980, the earlier planting that resulted from use of a stale seedbed was more adversely affected by the hot, dry weather during bloom and pod set. Average returns above direct costs for the nonirrigated treatments of Bedford were similar ($102.24 vs. $98.51) for both seedbed treatments. Therefore, the stale seedbed treatment that resulted in earlier planting increased average returns above estimated direct costs for Bedford only if irrigation was used.

Average returns above direct costs for the stale seedbed plantings of Bedford that were irrigated were $75.67 more per acre than for the stale seedbed plantings that were not irrigated. Average returns from the irrigated conventional seedbed treatment were $61.65 more per acre than from the nonirrigated conventional treatment (Table 6).

For Bragg or Braxton, average returns above direct costs for the stale seedbed plantings that were irrigated were $25.85 more per acre than returns from the conventional seedbed plantings that were irrigated. Without irrigation, the conventional seedbed treatment returned $20.45 more per acre than did the stale seedbed treatment. Hence, average returns above direct costs for Bragg or Braxton favor the stale seedbed treatment when irrigation is used, but favor the conventional seedbed treatment in the absence of irrigation. This trend was consistent across all 4 years of the study.

Average returns above direct costs for the stale seedbed plantings of Bragg or Braxton that were irrigated were $107.40 more

Table 6. Annual, total, and average estimated returns above estimated direct costs for irrigated (I) and nonirrigated (NI) soybeans planted with stale and conventional seedbed preparation on Sharkey clay.

Seedbed	Irrigation treatment	Variety	Year				4-year Total	4-year Av.
			1979	1980	1981	1982		
			$/acre					
Stale	I	Bedford	245.01	197.26	164.27	105.09	711.63	177.91
		Braxton	310.57	270.37	199.05	132.62	912.62	228.15
		AVERAGE	281.36	233.82	181.66	115.86	812.70	203.17
	NI	Bedford	282.19	58.02	34.58	34.16	408.95	102.24
		Braxton	309.58	97.54	38.96	36.93	483.01	120.75
		AVERAGE	295.88	77.78	36.77	35.54	445.98	111.50
Conventional	I	Bedford	206.15	244.68	139.05	50.75	640.63	160.16
		Braxton	294.80	227.36	180.23	106.81	809.20	202.30
		AVERAGE	250.48	236.02	159.64	78.78	724.92	181.23
	NI	Bedford	264.27	71.43	38.56	19.78	394.04	98.51
		Braxton	308.22	113.28	98.56	44.75	564.81	141.20
		AVERAGE	286.24	92.36	68.76	32.26	479.62	119.91

per acre than returns to the stale seedbed plantings that were not irrigated (Table 6). Average returns from the irrigated conventional seedbed treatment were $61.10 more per acre than from the nonirrigated conventional treatment.

Average returns above total specified costs are presented by variety in Table 7. The irrigated stale seedbed treatment using Bedford returned an average of $134.96 per acre above total costs compared to $112.00 per acre for the irrigated conventional seedbed treatment. For the nonirrigated treatments, returns above total costs averaged $83.73 per acre for the stale seedbed treatment and $74.79 for the conventional seedbed treatment. Thus, irrigation of the stale seedbed plantings of Bedford resulted in an average increase in returns of $22.96 per acre more than irrigation of the conventional seedbed plantings. For the nonirrigated stale seedbed planting, returns averaged only $8.94 per acre more than returns from the nonirrigated conventional seedbed treatment. These results indicate that use of the stale seedbed concept with plantings of Bedford that are irrigated will be more profitable than conventional seedbed plantings that are irrigated; however, only a slight advantage existed for the stale seedbed system over the conventional seedbed treatment under nonirrigated conditions.

Returns above total specified costs from the stale seedbed planting of Bedford averaged $134.96 per acre for the irrigated portion and $83.73 per acre for the nonirrigated plots, or a $51.23 advantage for irrigation. For the conventional seedbed treatment, the irrigated beans returned $112.00 compared to $74.79 per acre for the nonirrigated treatments, or $37.21 more per acre when irrigation was used.

Returns above estimated total costs when Bragg or Braxton were used averaged $185.20 and $154.14 per acre for the irrigated stale and conventional seedbed treatments, respectively, a difference of $31.06 per acre. For the nonirrigated treatments, returns averaged $102.24 per acre from the stale seedbed planting and $117.48 from the conventional seedbed plantings. Thus, results from the irrigated treatments favor the stale seedbed concept and results from the nonirrigated treatments favor the conventional seedbed planting of Bragg or Braxton.

The difference in planting dates resulting from the different seedbed treatments probably contributed to this differing response between the irrigated and nonirrigated portions with the later-maturing varieties. This differing pattern of estimated returns between the irrigated and nonirrigated treatments is contrary to the pattern observed with Bedford, and points out that the relative maturity of a variety is a factor to be considered when evaluating yield and economic response of the crop to both planting date and irrigation.

Average returns from the stale seedbed planting of Bragg or Braxton were $185.20 and $102.24 per acre from the irrigated and nonirrigated treatments, respectively, or a difference of $83.79 in favor of the irrigated treatment. For the conventional seedbed treatment, returns averaged $154.14 and $117.48 per acre for the irrigated and nonirrigated treatments, respectively, or a difference of only $36.66 in favor of irrigation. The reverse trend in yield difference between the two plantings (Appendix Table 11) under irrigated and nonirrigated conditions resulted in this $47.13 difference in net returns.

Table 7. Annual, total, and average estimated returns above estimated total costs for irrigated (I) and nonirrigated (NI) soybeans planted with stale and conventional seedbed preparation on Sharkey clay.

Seedbed	Irrigation treatment	Variety	Year				4-year Total	4-year Av.
			1979	1980	1981	1982		
			$/acre					
Stale	I	Bedford	208.73	155.78	118.32	56.99	539.82	134.96
		Braxton	274.29	228.89	153.10	84.52	740.80	185.20
		AVERAGE	245.09	192.34	135.71	65.76	638.90	159.73
	NI	Bedford	270.35	40.98	13.07	10.50	334.90	83.73
		Braxton	297.74	80.50	17.45	13.27	408.96	102.24
		AVERAGE	284.05	60.74	15.26	11.89	371.94	92.99
Conventional	I	Bedford	168.21	197.99	88.54	(6.75)	447.99	112.00
		Braxton	256.86	180.67	129.72	49.31	616.56	154.14
		AVERAGE	212.54	189.33	109.13	21.28	532.28	133.07
	NI	Bedford	250.77	49.18	12.49	(13.28)	299.16	74.79
		Braxton	294.72	91.03	72.49	11.69	469.93	117.48
		AVERAGE	272.75	70.11	42.49	(0.80)	384.54	96.14

Conclusions

The results of this study indicate an average advantage of $23 to $31 per acre for the stale seedbed concept under irrigated conditions. Results from the nonirrigated portions indicate only a slight advantage for the stale seedbed treatment with Bedford, and reduced returns with Bragg or Braxton. In all cases, the Group VII varieties Bragg or Braxton produced higher average estimated returns than did the Group V variety Bedford. This is because Bragg or Braxton always produced greater yields with only slightly higher specified costs per acre due to more irrigation water being applied. Evidently the later pod-filling period of Bragg or Braxton (September) compared to that of Bedford (August) resulted in more efficient utilization of rain and irrigation water in the presence of cooler September temperatures.

In general, the stale seedbed concept results in a shift of resources or inputs in the production of soybeans. For example, costs for chemicals will be higher and costs for machinery lower than those of the conventional seedbed concept of soybean production (Appendix Tables 1-8). Consequently, only slight reductions, or in some cases no reduction, in the cost of producing soybeans occur when changing to the stale seedbed concept. Since cost differences between the conventional and stale seedbed concepts are negligible, yield differences must occur for an economic advantage to be realized. In the nonirrigated plantings, no such yield difference occurred; thus, no real economic advantage for either concept was measured when water was a limiting factor. On the other hand, timely planting that may result from the use of the stale seedbed concept, coupled with irrigation, will result in higher yields and greater net returns. This indicates that the adoption of the stale seedbed concept can lead to a consistent increase in returns to the soybean grower who uses irrigation efficiently.

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Appendix Tables

Appendix Table 1. Production practices and estimated direct and total production costs associated with soybeans planted in a stale seedbed on Sharkey clay at Stoneville, MS in 1979.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk–28 ft.	0.40	0.45	0.29	0.00	1.14	0.57	0.88	2.59
Plant and preemerge	0.45	0.30	0.64	30.25[1]	31.64	0.63	0.71	32.98
Cultivate early	0.65	0.22	0.46	0.00	1.33	0.92	0.46	2.71
Cultivate late	0.40	0.16	0.29	0.00	0.85	0.57	0.34	1.76
Combine–20 ft.	0.00	4.15	0.92	0.00	5.07	0.00	6.76	11.83
Total specified	1.90	5.23	2.60	30.35	40.03	2.69	9.15	51.87
Interest on oper. capital[2]					2.01			2.01
Total including interest					42.04			53.88

[1] Preemerge alachlor plus linuron plus dinoseb plus seed.
[2] 11% annual interest rate.
Source: Parvin, et al., 1979.

Appendix Table 2. Production practices and estimated direct and total production costs associated with soybeans planted in a conventionally tilled seedbed on Sharkey clay at Stoneville, MS in 1979.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk–28 ft.	0.40	0.45	0.29	0.00	1.14	0.57	0.88	2.59
Disk–28 ft.	0.40	0.45	0.29	0.00	1.14	0.57	0.88	2.59
Field cultivate–21 ft.	0.40	0.23	0.29	0.00	0.92	0.57	0.55	2.04
Plant and preemerge	0.45	0.30	0.64	24.89[1]	29.28	0.63	0.71	27.62
Cultivate early	0.65	0.22	0.46	0.00	1.33	0.92	0.46	2.71
Combine–20 ft.	0.00	4.15	0.92	0.00	5.07	0.00	6.76	11.83
Total specified	2.30	5.80	2.89	24.89	35.88	3.26	10.24	49.38
Interest on oper. capital[2]					1.79			1.79
Total including interest					37.67			51.17

[1] Seed plus alachlor plus linuron.
[2] 11% annual interest rate.
Source: Parvin, et al., 1979.

Appendix Table 3. Production practices and estimated direct and total production costs associated with soybeans planted in a stale seedbed on Sharkey clay at Stoneville, MS in 1980.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk and incorporate–28 ft.	0.97	0.62	0.40	6.30[1]	8.29	0.88	1.14	10.41
Field cultivate–21 ft.	0.75	0.23	0.31	0.00	1.29	0.68	0.57	2.54
Plant and preemerge	0.99	0.41	0.82	31.05[2]	33.27	0.89	0.99	35.15
Cultivate early	1.20	0.24	0.50	0.00	1.94	1.08	0.52	3.54
Cultivate late	0.75	0.15	0.31	0.00	1.21	0.68	0.32	2.21
Combine–20 ft.	0.00	6.23	0.92	0.00	7.15	0.00	9.19	16.34
Total specified	4.66	7.88	3.26	37.35	53.15	4.21	12.83	70.19
Interest on oper. capital[3]					2.76			2.76
Total including interest					55.91			72.95

[1] Preplant incorporated trifluralin.
[2] Seed plus alachlor plus linuron plus dinoseb.
[3] 12% annual interest rate.
Source: Parvin, et al., 1980.

Appendix Table 4. Production practices and estimated direct and total production costs associated with soybeans planted in a conventionally tilled seedbed on Sharkey clay at Stoneville, MS in 1980.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk and incorporate–28 ft.	0.97	0.62	0.40	6.30[1]	8.29	0.88	1.24	10.41
Field cultivate–21 ft.	0.75	0.23	0.31	0.00	1.29	0.68	0.57	2.54
Disk–28 ft.	0.75	0.45	0.31	0.00	1.51	0.68	0.91	3.10
Field cultivate–21 ft.	0.75	0.23	0.31	0.00	1.29	0.68	0.57	2.54
Field cultivate–21 ft.	0.75	0.23	0.31	0.00	1.29	0.68	0.57	2.54
Plant and preemerge	0.99	0.41	0.82	25.69[2]	27.91	0.89	0.99	29.79
Cultivate and post early	1.44	0.43	0.60	3.66[3]	6.13	1.30	0.92	8.35
Cultivate and post late	0.97	0.29	0.40	2.29[4]	3.95	0.88	0.62	5.45
Combine–20 ft.	0.00	6.23	0.92	0.00	7.15	0.00	9.19	16.34
Total specified	7.37	9.12	4.38	37.94	58.81	6.67	15.58	81.06
Interest on oper. capital[5]					3.06			3.06
Total including interest					61.87			84.12

[1] Preplant incorporated trifluralin.
[2] Seed plus alachlor plus linuron.
[3] Bentazon.
[4] Acifluorfen.
[5] 12% annual interest rate.
Source: Parvin, et al., 1980.

Appendix Table 5. Production practices and estimated direct and total production costs associated with soybeans planted in a stale seedbed on Sharkey clay at Stoneville, MS in 1981.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk and incorporate–28 ft.	1.20	0.70	0.44	6.57[1]	8.91	1.12	1.49	11.52
Plant and preemerge	1.51	0.68	1.33	25.00[2]	28.52	1.40	1.80	31.72
Cultivate early	1.47	0.31	0.54	0.00	2.32	1.37	0.71	4.40
Cultivate and post late	1.20	0.34	0.44	2.84[3]	4.82	1.12	0.79	6.73
Cultivate late	0.92	0.19	0.33	0.00	1.44	0.86	0.44	2.74
Combine–20 ft.	0.00	6.13	1.03	0.00	7.16	0.00	10.41	17.57
Total specified	6.30	8.35	4.11	34.41	53.17	5.87	15.64	74.68
Interest on oper. capital[4]					3.50			3.50
Total including interest					56.67			78.18

[1] Preplant incorporated trifluralin.
[2] Seed plus linuron plus dinoseb.
[3] Linuron plus 2,4-DB
[4] 14% annual interest rate.
Source: Parvin, et al., 1981.

Appendix Table 6. Production practices and estimated direct and total production costs associated with soybeans planted in a conventionally tilled seedbed on Sharkey clay at Stoneville, MS in 1981.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk and incorporate–28 ft.	1.20	0.70	0.44	6.57[1]	8.91	1.12	1.49	11.52
Field cultivate–21 ft.	0.92	0.33	0.33	0.00	1.58	0.86	0.86	3.30
Disk–28 ft.	0.92	0.50	0.33	0.00	1.75	0.86	1.06	3.67
Plant and preemerge	1.51	0.68	1.33	23.10[2]	26.62	1.40	1.80	29.82
Cultivate early	1.47	0.31	0.54	0.00	2.32	1.37	0.71	4.40
Cultivate and post late	1.77	0.51	0.65	2.84[3]	5.77	1.65	1.18	8.60
Cultivate late	0.92	0.19	0.33	0.00	1.44	0.86	0.44	2.74
Combine–20 ft.	0.00	6.13	1.03	0.00	7.16	0.00	10.41	17.57
Total specified	7.79	8.85	4.65	32.51	55.55	8.12	17.95	81.62
Interest on oper. capital[4]					3.39			3.39
Total including interest					58.94			85.01

[1] Preplant incorporated trifluralin.
[2] Seed plus linuron plus dinoseb.
[3] Linuron plus 2,4-DB.
[4] 14% annual interest rate.
Source: Parvin, et al., 1981.

Appendix Table 7. Production practices and estimated direct and total production costs associated with soybeans planted in a stale seedbed on Sharkey clay at Stoneville, MS in 1982.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk and incorporate–28 ft.	1.90	0.87	0.66	8.19[1]	11.62	1.81	1.95	15.38
Plant and preemerge	1.05	0.61	0.44	15.69[2]	17.79	0.99	1.72	20.50
Cultivate early	1.40	0.31	0.58	0.00	2.29	1.32	0.77	4.38
Cultivate late	0.87	0.20	0.36	0.00	1.43	0.83	0.48	2.74
Cultivate late	0.87	0.20	0.36	0.00	1.43	0.83	0.48	2.74
Combine–20 ft.	0.00	7.64	1.09	0.00	8.73	0.00	12.64	21.37
Total specified	6.09	9.83	3.49	23.88	43.29	5.62	18.04	66.95
Interest on oper. capital[3]					3.03			3.03
Total including interest					46.32			69.98

[1] Preplant incorporated trifluralin.
[2] Seed plus metribuzin plus dinoseb.
[3] 16% annual interest rate.
Source: Hamill, 1982.

Appendix Table 8. Production practices and estimated direct and total production costs associated with soybeans planted in a conventionally tilled seedbed on Sharkey clay at Stoneville, MS in 1982.

Operation	Direct costs					Fixed costs		
	Tractor	Equipment	Labor	Materials	Total	Tractor	Equipment	Total
	$/acre							
Disk and incorporate–28 ft.	1.90	0.87	0.66	8.19[1]	11.62	1.81	1.95	15.38
Disk–28 ft.	1.05	0.68	0.36	0.00	2.09	1.01	1.53	4.63
Disk–28 ft.	1.05	0.68	0.36	0.00	2.09	1.01	1.53	4.63
Field cultivate–34 ft.	0.84	0.57	0.29	0.00	1.70	0.80	1.57	4.07
Plant and preemerge	1.05	0.61	0.44	13.92[2]	16.02	0.99	1.72	18.73
Roll	0.79	0.06	0.36	0.00	1.21	0.76	0.25	2.22
Cultivate early	1.40	0.31	0.58	0.00	2.29	1.32	0.77	4.38
Cultivate early	1.40	0.31	0.58	0.00	2.29	1.32	0.77	4.38
Cultivate late	0.87	0.20	0.36	0.00	1.43	0.83	0.48	2.74
Combine–20 ft.	0.00	7.64	1.09	0.00	8.73	0.00	12.64	21.37
Total specified	10.35	11.93	5.08	22.11	49.47	8.85	23.21	82.53
Interest on oper. capital[3]					3.46			3.46
Total including interest					52.93			85.99

[1] Preplant incorporated trifluralin.
[2] Seed plus metribuzin plus dinoseb.
[3] 16% annual interest rate.
Source: Hamill, 1982

Appendix Table 9. Record of irrigation of two soybean varieties planted on two dates at Stoneville, MS 1979-1982.

	Bedford				Bragg or Braxton			
	May planting		June planting		May planting		June planting	
Year	Date	Amount	Date	Amount	Date	Amount	Date	Amount
		(in.)		(in.)		(in.)		(in.)
1979	July 20	1.75	Aug. 20	3.40	Aug. 17	2.55	Aug. 17	2.30
	Aug. 10	2.80	Sept. 19	3.80	Sept. 12	3.40	Sept. 19	4.00
	Aug. 30	2.90	TOTAL	7.20	TOTAL	5.95	TOTAL	6.30
	TOTAL	7.45						
1980	July 9	3.15	July 31	3.70	July 28	3.85	Aug. 11	3.85
	July 18	3.70	Aug. 13	3.85	Aug. 6	3.35	Aug. 22	3.85
	July 31	2.85	Aug. 25	3.85	Aug. 14	4.70	Sept. 3	3.00
	Aug. 13	3.85	Sept. 9	3.85	Aug. 22	3.85	Sept. 12	3.85
	Aug. 22	3.85	Sept. 18	3.85	Sept. 3	3.70	Sept. 22	3.85
	Sept. 3	3.50	TOTAL	19.10	Sept. 12	3.85	TOTAL	18.40
	TOTAL	20.90			Sept. 22	3.85		
					TOTAL	27.15		
1981	July 22	4.95	July 31	3.85	July 20	5.00	July 30	3.85
	Aug. 3	3.85	Aug. 19	3.85	Aug. 3	3.85	Aug. 19	3.85
	Aug. 20	3.85	TOTAL	7.70	Aug. 20	3.85	Sept. 14	3.85
	TOTAL	12.65			Sept. 14	3.85	TOTAL	11.55
					TOTAL	16.55		
1982	July 21	3.85	July 29	3.85	July 21	3.85	July 29	3.85
	Aug. 11	3.85	Aug. 25	3.85	Aug. 9	3.85	Aug. 25	3.85
	Aug. 30	3.85	Sept. 8	3.85	Aug. 27	3.85	Sept. 8	3.85
	TOTAL	11.55	TOTAL	11.55	Sept. 8	3.85	TOTAL	11.55
					TOTAL	15.40		

Appendix Table 10. Estimated costs of a gated-pipe system irrigating 160 acres, Mississippi Delta, 1983.

Item	Investment	Estimated life	Annual costs
FIXED COSTS			
Engine	$ 6,500	15	$ 433.53
Well, pump, gearhead	13,500	20	675.00
Fuel tank and lines	1,000	20	50.00
8-inch gated pipe at $3.00/ft.	7,920	15	528.00
Total investment	$28,920		
Average annual interest			2,024.40
Insurance			200.00
Total annual fixed costs			$3,910.73
Annual fixed cost per acre			$ 24.44

DIRECT COSTS	4 inches per acre	Approximate costs per acre-inch
Engine repairs at 70% of new costs	$ 0.50	$0.13
Diesel fuel at $1.15/gallon	6.98	1.75
Oil at $4.00/gallon	0.04	0.01
Tractor fuel at $1.15/gallon (25 hours of operation)	0.36	0.09
Labor at $4.40/hour	2.85	0.71
Pipe replacement (2% of original pipe investment)	0.99	0.25
Total direct costs	$11.73	$2.94

Appendix Table 11. Yield of irrigated and nonirrigated soybeans planted on two dates on Sharkey clay at Stoneville, MS 1979-1982.

Year	Planting date	Nonirrigated			Irrigated		
		Variety			Variety		
		Bedford	Bragg or Braxton	Average	Bedford	Bragg or Braxton	Average
		bu/acre					
1979	May 17	50.9	55.2	53.0	48.5	58.1	53.3
	June 11	47.4	54.3	50.8	41.6	55.1	48.4
	AVERAGE	49.2	54.8	52.0	45.0	56.6	50.8
1980	May 12	14.7	19.8	17.2	40.6	52.4	46.5
	June 3	17.2	22.6	19.9	46.8	44.3	45.6
	AVERAGE	16.0	21.2	18.6	43.7	48.4	46.0
1981	May 13	14.6	15.3	15.0	41.3	48.7	45.0
	June 4	15.6	25.2	20.4	35.3	43.7	39.5
	AVERAGE	15.1	20.2	17.7	38.3	46.2	42.2
1982	May 12	14.5	15.0	14.8	33.4	40.4	36.9
	May 28	13.1	17.6	15.4	24.8	34.9	29.8
	AVERAGE	13.8	16.3	15.1	29.1	37.6	33.4

Appendix Table 12. Seasonal yearly average price received per bushel of soybeans in Mississippi, 1979-1982[1].

Year	Seasonal price
	$/bu
1979	6.37
1980	7.75
1981	6.25
1982	5.55

[1] Source: Mississippi Crop and Livestock Reporting Service, *Mississippi Agricultural Statistics*, selected issues.

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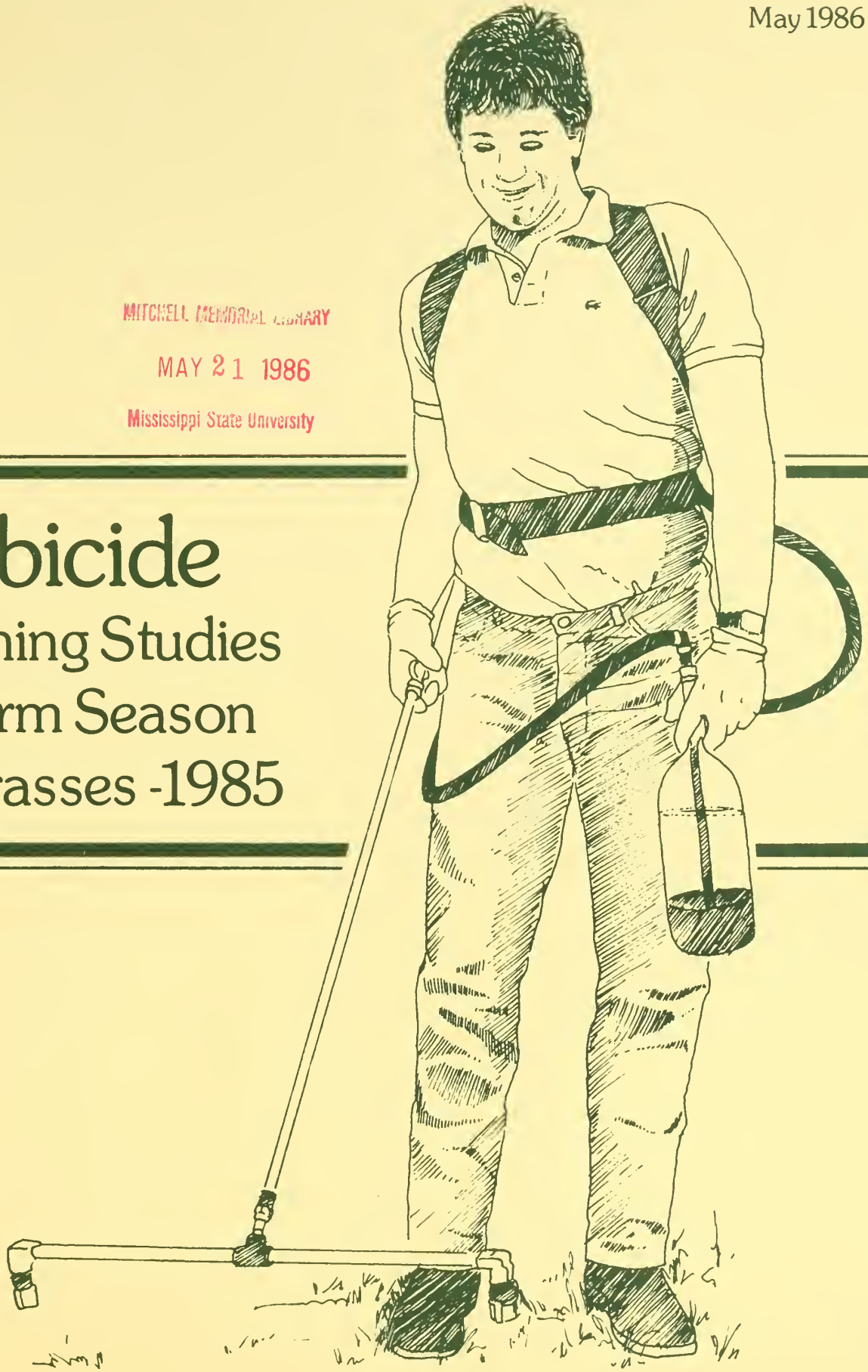

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Herbicide Screening Studies in Warm Season Turfgrasses – 1985

Introduction

Numerous herbicides are available for control of grassy and broadleaf weeds in warm season turfgrasses. Preemergence herbicides commonly used in turfgrasses include: Balan®, Betasan®, Dacthal®, Ronstar®, and Princep®.

Buctril® or Brominal®, 2,4-D, MCPP (mecoprop), Banvel®, or dichlorprop–used alone or in various combinations (2,4-D, MCPP, dichlorprop, or Banvel)–are the more important postemergence herbicides for broadleaf weed control in bermudagrass and other warm season turfgrasses.

Postemergence control of grass weeds in bermudagrass and zoysiagrass is achieved with MSMA or other organic arsenical herbicides. Asulox® is the only available postemergence herbicide to selectively control grass weeds in St. Augustinegrass. Poast® is the only available herbicide for grass weed control in centipedegrass.

These herbicides control many of the weeds in warm season turfgrass if applied at the appropriate rate and time. However, many weeds are tolerant of a particular herbicide, or its use is limited by turfgrass species or cultivar intolerance. Consequently, a need exists to evaluate new chemicals and to look at mixtures or formulations of materials presently available to increase our capability of managing weeds in turfgrasses. The purpose of the research reported here was to evaluate the effectiveness of new chemicals and/or formulations and mixtures of herbicides presently labeled for use in warm season turfgrasses.

Methods and Materials

Tests were initiated in common bermudagrass turf at various locations to evaluate herbicides for a wide range of problems.

(1) Postemergence control of broadleaf weeds in late winter was tested at the MAFES Plant Science Research Center and Eupora Country Club, Eupora, MS.

(2) Preemergence control of crabgrass was evaluated at the MAFES Plant Science Research Center.

(3) Alternatives to Banvel in 2,4-D/Banvel mixture were evaluated for postemergence control of broadleaf weeds in late winter at the Plant Science Research Center.

(4) Tolerance and weed control with BAS 514 (BASF) were tested at the Plant Science Research Center.

(5) Tolerance and weed control studies with Asulox + atrazine in Raleigh St. Augustinegrass were conducted at Pearl River Valley Turf Farm, Wiggins, MS.

(6) Postemergence control of Virginia buttonweed with Super D Trimec® and Weedone® DPC was evaluated at Live Oaks Country Club, Jackson, MS.

(7) Weed control with Quadmec® was studied on the Mississippi State University Golf Course, Starkville, MS.

(8) Weed control and turf tolerance to XE-1019 (Chevron Chem. Co.) were tested on low maintenance turf at the Plant Science Research Center.

(9) The effect of Frigate® on activity of Roundup® for bermudagrass control was measured at the MAFES Plant Science Research Center.

Turfs at the MAFES Plant Science Research Center were maintained as home lawns, grown on a Marietta fine sandy loam soil, mowed weekly at 2-3 inches and fertilized with nitrogen at a rate equivalent to 3-4 pounds per 1,000 square feet annually. The preemergence test was overseeded with smooth crabgrass and goosegrass (2 quarts of each on 18,000 square feet) prior to treatment with herbicides. Infestations of smooth crabgrass mixed with Southern crabgrass in the plot area were extremely heavy, while the goosegrass germination was not sufficient to make control evaluations. The area in which the XE-1019 compound was evaluated was not fertilized during 1985.

Tests at Eupora Country Club were on common bermudagrass maintained as golf course turf on an Oaklimeter silt loam soil, mowed one or two times weekly, and fertilized with 2 pounds active N per thousand square feet annually.

Plot areas at Live Oaks Country Club were on common bermudagrass, golf course rough, mowed weekly at 2 inches and receiving one to 2 pounds active N per thousand square feet.

At Pearl River Valley Turf Farm, Raleigh St. Augustinegrass was grown under sod production conditions, mowed weekly, and fertilized with 6-8 pounds active N per thousand square feet yearly.

Postemergence control of winter

broadleaf weeds was evaluated at the MAFES Plant Science Research Center and Eupora Country Club on natural infestations of weeds. The common bermudagrass was dormant and the plot areas had not been mowed since late the previous fall.

Plots were 5 feet by 15 feet with one exception—the test with XE-1019 was on plots measuring 15 feet by 40 feet. Each plot was replicated four times in a randomized complete block design or a two-way whole split plot design (Banvel alternative study). In this latter test, whole plots were 2,4-D or no 2,4-D and alternative treatments were main plots. Herbicide applications were made with a carbon dioxide powered backpack sprayer in water at 25 gallons per acre (175 gallons per acre of the 10% PRE-M® prill formulation in the preemergence test); or the appropriate amount of granular herbicide was mixed with sand (approximately 2 quarts per 50 square feet) and uniformly applied to the plots. Specific treatments are shown in tables in the results section.

Results and Discussion

Winter Postemergence Tests

New herbicides evaluated at the MAFES Plant Science Research Center included sulfonated ureas (Ally®, Classic®, Glean®, and Oust®), Scepter®, Super Trimec, and CGA-131036 (Ciba-Geigy experimental compound) compared to Trimec® (Tables 1 and 2). Broadleaf weed control was generally poor for all herbicides including the herbicide standard, Trimec, which is an amine formulation of a mixture of dimethylamine salts of 2,4-D plus mecoprop plus Banvel. Of the newer compounds, Ally, Classic, Glean, Oust, and Scepter showed potential activity on white clover at the highest rates. The herbicidal activity of CGA-131036 on white clover was noticeably weaker than that of the other newer materials. Super Trimec (2,4-D isoctyl ester plus dichlorprop butoxyethanol ester plus Banvel acid) gave significantly better control in this test than Trimec.

Dandelion control was good with all herbicides except Trimec at either rate tested. Also, control of mouseear chickweed was good except with Trimec and the lowest rate of Scepter. Annual fleabane control was poor with all herbicides.

Ally, Glean, Super Trimec, and the higher rates of Scepter appear to have potential use for corn speedwell control based on the response observed in this study. The activity on corn speedwell observed with Scepter, which gave good control at 1.0 pound active ingredient per acre, is inconsistent with observations in other studies with Scepter conducted during the

Table 1. Evaluation of postemergence herbicides for late winter weed control in bermudagrass turf[1].

Herbicide	Rate[2] lb ai/A	% White clover control [3]			% Dandelion control [3]			% Mouseear chickweed control[3]		
		4 WAT	6 WAT	10 WAT	4 WAT	6 WAT	10 WAT	4 WAT	6 WAT	10 WAT
CGA-131036	0.022	23	18	0	33	50	68	33	0	70
CGA-131036	0.036	28	35	10	18	75	68	40	15	80
CGA-131036 + Trimec	0.022 0.375	38	30	8	25	75	80	43	8	85
Trimec	0.375	25	23	0	10	45	3	0	8	13
Trimec	0.75	25	10	10	15	65	0	30	10	63
Scepter	0.25	18	53	25	23	0	68	40	10	38
Scepter	0.50	28	75	48	33	20	70	38	8	53
Scepter	1.00	23	85	68	30	38	78	48	78	60
S-Trimec	0.75	100	55	78	58	88	83	73	85	90
Glean	0.031	35	55	58	53	23	75	35	85	35
Glean	0.063	35	78	73	45	45	73	38	88	65
Classic	0.031	50	23	63	45	63	58	38	28	68
Classic	0.013	38	23	53	38	73	25	33	33	65
Oust	0.031	38	90	78	43	90	78	58	90	85
Oust	0.063	45	88	78	43	90	78	58	90	85
Ally	0.031	43	78	80	50	90	75	25	83	88
Ally	0.063	38	90	83	48	90	80	50	90	85
Check		0	0	0	0	0	0	0	0	0
LSD (0.05)		16	38	18	14	31	20	20	28	18
Coefficient of variability		33	54	30	31	39	24	38	49	20

[1] Conducted at MAFES Plant Science Research Center. All treatments were applied in combination with a non-ionic surfactant (Ortho X-77 Spreader®) at 0.25% by volume. Herbicide applications were made on March 13, 1985.

[2] Rate for Trimec and Super Trimec is that of the 2,4-D in the three-way mixture.

[3] WAT = Weeks after treatment.

late winter and early spring of 1985. This was the only one of six studies in which corn speedwell was present that any significant control was observed.

Within this group of newer herbicides, the broadest spectrum of broadleaf weed control was generally observed with Super Trimec, which differs from Trimec in two ways. First, the mixture contains dichlorprop instead of mecoprop. Secondly, 2,4-D and dichlorprop are esters and the Banvel is the acid formulation in Super Trimec while all three components of the Trimec mixture are amines. The differences in herbicidal activity of dichlorprop versus mecoprop and the differences in activity of an ester formulation of the two phenoxy materials in the mixture probably accounts for the better weed control observed with Super Trimec.

These materials were evaluated in a duplicate experiment at Eupora Country Club. All herb-

Table 2. Evaluation of postemergence herbicides for late winter weed control in bermudagrass turf[1].

Herbicide	Rate[2] lb ai/A	% Annual fleabane control[3] 4 WAT	% Corn speedwell control[3] 6 WAT
CGA-131036	0.022	35	0
CGA-131036	0.036	46	15
CGA-131036 + Trimec	0.022 + 0.375	33	8
Trimec	0.375	25	8
Trimec	0.75	20	10
Scepter	0.25	30	10
Scepter	0.50	28	8
Scepter	1.00	37	78
S-Trimec	0.75	53	85
Glean	0.031	50	85
Glean	0.063	40	88
Classic	0.031	38	28
Classic	0.013	38	33
Oust	0.031	33	23
Oust	0.063	33	90
Ally	0.031	43	83
Ally	0.063	43	90
Check		0	0
LSD (0.05)		16	28
Coefficient of variability		32	49

[1] Conducted at MAFES Plant Science Research Center. All treatments were applied in combination with a non-ionic surfactant (Ortho X-77 Spreader) at 0.25% by volume. Herbicide applications were made on March 13, 1985.

[2] Rate for Trimec and Super Trimec is that of the 2,4-D in the three-way mixture.

[3] WAT = Weeks after treatment.

Table 3. Evaluation of postemergence herbicides for late winter weed control in bermudagrass turf[1].

Herbicide	Rate[2] lb ai/A	% White clover control[3] 4 WAT	6 WAT	% Buttercup control[3] 4 WAT	6 WAT	% Mouseear chickweed control[3] 4 WAT	6 WAT
CGA-131036	0.022	25	40	28	48	38	58
CGA-131036	0.036	33	45	48	92	48	53
CGA-131036 + Trimec	0.022 + 0.375	18	40	33	55	45	40
Trimec	0.375	10	15	23	48	28	28
Trimec	0.75	15	25	23	58	35	55
Scepter	0.25	18	30	33	63	40	60
Scepter	0.50	18	40	50	78	43	65
Scepter	1.00	30	48	48	78	55	83
S-Trimec	0.75	47	93	50	100	58	95
Glean	0.031	33	58	50	83	50	78
Glean	0.063	28	50	38	85	50	70
Classic	0.031	30	30	55	83	43	63
Classic	0.013	30	45	62	83	40	68
Oust	0.031	35	68	55	90	60	75
Oust	0.063	35	73	73	90	55	85
Ally	0.031	33	63	55	90	63	78
Ally	0.063	50	73	65	88	60	85
Check		0	0	0	0	0	0
LSD (0.05)		12	16	19	21	16	16
Coefficient of variability		30	25	30	20	25	19

[1] Conducted at Eupora Country Club. All treatments were applied in combination with a non-ionic surfactant (Ortho X-77 Spreader) at 0.25% by volume. Herbicide applications were made on March 18, 1985.

[2] Rate for Trimec and Super Trimec is that of the 2,4-D in the three-way mixture.

[3] WAT = Weeks after treatment.

icides performed better at this location than at the MAFES Plant Science Research Center on white clover and mouseear chickweed, the two weed species present in both studies (Table 3). When comparisons were made 6 weeks after treatment, Super Trimec again performed better than Trimec or other herbicides on white clover, mouseear chickweed, and buttercup.

Standard Preemergence Test

A number of herbicides were evaluated at the MAFES Plant Science Research Center (Tables 4, 5, and 6). Note that direct comparisons can be made between the data within rating dates.

Extremely poor control of crabgrass (a mixture of smooth and Southern crabgrasses) was observed with CGA-131036 and with combinations of this experimental compound and Bicep® or Aatrex® (Table 6). Other compounds in which control was assessed as poor (less than 70%) were Balan, EL 107 (Elanco Products), and Glean.

All formulations and rates of PRE-M, with the exception of the wettable powder (wp) formulation at 2.7 pound active ingredient per acre, gave 70% or greater control of the crabgrass mixture (Table 5). This level of control with PRE-M was observed for the duration of the study, i.e., 6 months following a single application or 6 months following the initial application of a multiple application treatment. Although not significantly better at the final evaluation, 6 months after the first or initial application control with the 10% prill fertilizer formulation of PRE-M was slightly higher than with either the wettable powder formulation or the water dispersable (WD) formulations. An additional application of 1.5 pounds active ingredient per acre PRE-M 60 or 90 days following

Table 4. Crabgrass control in common bermudagrass[1].

Herbicide	Formulation	Rate lb ai/A	Applied Date	% Crabgrass control[2]			
				2 MAIT	3 MAIT	4 MAIT	6 MAIT
CGA-131036	20 DF	0.022	March	0	0	0	0
CGA-131036	20 DF	0.036	March	0	8	5	0
CGA-131036	20 DF	0.054	March	5	0	0	0
Bicep	4.5 LF	4.0	March	100	98	83	58
Bicep	4.5 LF	6.0	March	100	88	73	48
Bicep	4.5 LF	8.0	March	100	100	93	63
CGA-131036	20 DF	0.022	March	78	63	43	25
+ Bicep	4.5 LF	2.0	March				
CGA-131036	20 DF	0.022	March	35	18	15	5
+ Aatrex	4 LF	2.0	March				
Glean	75 DF	0.022	March	20	38	3	0
EL-107	75 DF	0.5	March	18	28	28	5
EL-107	75 DF	1.0	March	33	70	33	18
Surflan	4 AS	3.0	March	100	100	98	83
Surflan	4 AS	3.0	March	100	100	98	85
+ Surflan	4 AS	3.0	May				
Balan	75 DF	3.0	March	20	55	13	0
Balan XL	2 G	3.0	March	100	100	95	90
Balan XL	2 G	3.0	March	100	100	93	85
+ Balan XL	2 G	3.0	May				
Ronstar	50 WP	2.0	March	98	100	73	58
Ronstar	50 WP	4.0	March	100	100	93	75
Ronstar	50 WP	8.0	March	100	100	100	93
Ronstar	50 WP	3.0	March	100	100	98	85
+ Buctril	2 EC	1.0	March				
Devrinol	50 WP	4.0	March	95	100	98	68
Devrinol	50 WP	6.0	March	100	100	98	83
LSD (0.05)				22	20	20	22
Coefficient of variability				22	17	19	27

[1] Conducted at MAFES Plant Science Research Center. Initiated on March 13 and 14, 1985 with 60-day applications on May 10, 1985 and 90-day applications on June 6, 1985.

[2] MAIT = Months after initial treatment.

the initial treatment did not significantly increase crabgrass control (Table 5). Similar observations were made with 60 or 90-day followup applications of Balan XL® and Surflan® (Table 4).

Combination treatments in which a preemergence herbicide was tank mixed (Dacthal, Devrinol®, or PRE-M) or applied at the same time as a granular formulation (Ronstar or Balan XL) with the first of a two-application postemergence MSMA treatment in May gave good control of crabgrass (Table 6). Although the combination treatments Balan XL, Devrinol, PRE-M, and Ronstar exhibited slightly higher levels of control, they were not significantly better than the MSMA treatment alone.

Alternative to Banvel

Ally, Classic, Glean, and Scepter were evaluated as alternatives to Banvel in a 2,4-D/Banvel mixture for winter broadleaf weed control at the MAFES Plant Science Research Center. All alternative herbicides were compared to 0.1 pound active ingredient per acre Banvel or 1.0 pound active ingredient per acre 2,4-D amine + 0.1 pound active ingredient per acre Banvel (Table 7). None of the alternative herbicides in combination with 2,4-D gave significantly higher control of white clover, mouseear chickweed, or dandelion than the herbicide without 2,4-D if 40% control was achieved. Ally at 0.063 pounds (1 ounce) active ingredient per acre was consistently the best treatment with 80% or

Table 5. Crabgrass control with three formulations of PRE-M[1].

Herbicide	Formulation	Rate lb ai/A	Applied Date	% Crabgrass control[2] 2 MAIT	3 MAIT	4 MAIT	6 MAIT
Ronstar	50 WP	2.0	March	98	100	73	58
----------Water dispersable formulation[3]----------							
PRE-M	60 WD	2.7	March	98	100	93	70
PRE-M	60 WD	3.0	March	100	100	90	70
PRE-M	60 WD	3.3	March	100	100	95	70
PRE-M	60 WD	3.0	March	100	100	98	73
+ PRE-M	60 WD	1.5	May				
PRE-M	60 WD	3.0	March	100	100	95	75
+ PRE-M	60 WD	1.5	June				
----------Wettable powder formulation[3]----------							
PRE-M	50 WP	2.7	March	98	90	90	55
PRE-M	50 WP	3.0	March	98	100	98	70
PRE-M	50 WP	3.3	March	100	100	100	75
PRE-M	50 WP	3.0	March	100	100	100	85
+ PRE-M	50 WP	1.5	May				
PRE-M	50 WP	3.0	March	98	100	98	73
+ PRE-M	50 WP	1.5	June				
----------Fertilizer prill formulation[4]----------							
PRE-M	10 PL	2.7	March	100	100	100	85
PRE-M	10 PL	3.0	March	100	100	98	88
PRE-M	10 PL	3.3	March	100	100	98	90
PRE-M	10 PL	3.0	March	100	100	100	90
+ PRE-M	10 PL	1.5	May				
PRE-M	10 PL	3.0	March	100	100	100	88
PRE-M	10 PL	1.5	June				
LSD (0.05)				22	20	20	22
Coefficient of variability				22	17	19	27

[1] Conducted at MAFES Plant Science Research Center. Initiated on March 13 and 14, 1985 with 60-day applications on May 10, 1985 and 90-day applications on June 6, 1985.
[2] MAIT = Months after initial treatment.
[3] Applied in water at 25 gallons per acre.
[4] Applied in water at 175 gallons per acre.

better control of all three weeds being observed.

Evaluation of BAS 514

This experimental compound from BASF Wyndotte was screened for weed control and tolerance of three turfgrasses at the MAFES Plant Science Research Center. Poast was included as the standard herbicide for comparison on common bermudagrass, Tifway bermudagrass, and common centipedegrass mowed weekly at a 2 to 3-inch height under home lawn conditions.

Significant injury was observed with BAS 514 on common centipedegrass at all rates for 21 days following treatment (Table 8). This injury was evident throughout the 51-day duration of the study except at the 0.5 pound active ingredient per acre rate.

Injury was also observed on both common and Tifway bermudagrasses but the injury, except at 9 days after treatment on the Tifway bermudagrass, was significantly less than that observed with the Poast treatment. Slight injury was observed on common bermudagrass at 15 days after treatment, but was not significant.

Smooth crabgrass control with BAS 514 was equal to that observed with Poast (Table 9). BAS 514 gave 70 to 90% control of smooth crabgrass, and with a few exceptions, of dandelion, slender aster, and white clover when evaluated at 51 or 78 days after the

Table 6. Smooth crabgrass control with preemergence herbicides applied at the time of MSMA treatment in common bermudagrass[1].

Herbicide	Formulation	Rate lb ai/A	Applied Date	% Crabgrass control[2]			
				2 MAIT	3 MAIT	4 MAIT	6 MAIT
Check				0	0	0	0
Ronstar	50 WP	2.0	March 13	98	100	73	58
Dacthal	75 WP	10.5	March 13	85	70	55	20
+ Dacthal	75 WP	7.5	May 10				
Dacthal	75 WP	10.5	May 10	100	98	78	--
+ MSMA	6 L	2.0	May 10				
+ X-77		0.25%	May 17				
+ Dacthal	75 WP	7.5	July 8				
PRE-M	60 WD	3.0	May 10	100	100	88	--
+ MSMA	6 L	2.0	May 10				
+ X-77		0.25%	May 10				
+ MSMA	6 L	2.0	May 17				
+ X-77		0.25%	May 17				
Devrinol	50 WP	4.0	May 10	100	80	80	--
+ MSMA	6 L	2.0	May 10				
+ X-77		0.25%	May 10				
+ MSMA	6 L	2.0	May 17				
+ X-77		0.25%	May 17				
Ronstar	2 G	3.0	May 10	100	100	88	--
+ MSMA	6 L	2.0	May 10				
+ X-77		0.25%	May 10				
+ MSMA	6 L	2.0	May 17				
+ X-77		0.25%	May 17				
Balan XL	2 G	3.0	May 10	100	100	90	--
+ MSMA	6 L	2.0	May 10				
+ X-77		0.25%	May 10				
+ MSMA	6 L	2.0	May 17				
+ X-77		0.25%	May 17				
MSMA	6 L	2.0	May 10	100	100	75	--
+ X-77		0.25%	May 10				
+ MSMA	6 L	2.0	May 17				
+ X-77		0.25%	May 17				
LSD (0.05)				22	20	20	22
Coefficient of variability				22	17	19	27

[1] Conducted at MAFES Plant Science Research Center. Initiated on March 13 and 14, 1985.
[2] MAIT = Months after initial treatment.

September 4, 1985 application (Table 10).

St. Augustine Tolerance to Atrazine Plus Asulox

Can atrazine for preemergence control be applied at the same time Asulox is applied for postemergence grass weed control? This study was conducted at the Pearl River Valley Turf Farm on July 19, 1985 to answer this question.

No significant injury was observed on Raleigh St. Augustinegrass following Asulox applications of 1.5, 2.0, or 2.5 pounds active ingredient per acre alone or in combination with atrazine at 1.5 pounds active ingredient per acre (Table 11). Broadleaf signalgrass control was increased by the addition of atrazine only when Asulox was used at the 1.5 pounds active ingredient per acre.

Hormone Mixtures for Virginia Buttonweed

All herbicide treatments resulted in 75% or better control at 25 days after treatment (Table 12). However, control had declined at the 39-day rating in all treatments. EH 680 gave the highest level of control throughout the duration of the experiment. No significant bermudagrass injury was observed.

Evaluation of Quadmec for Goosegrass

Quadmec treatment resulted in less than 60% goosegrass control at both rating dates (Table 13). Quadmec is a prepackaged formulation of MSMA + Trimec (2,4-D + mecoprop + Banvel). Injury to common bermudagrass and goosegrass control were both higher than the equivalent tank mixed treatment. However, goosegrass control was considered unacceptable in this study with either the prepackage mix (Quadmec) or the tank mix of Trimec plus MSMA.

Evaluation of XE-1019

This study was located on a three-to-one sloped ditch bank at the MAFES Plant Science Research Center to evaluate the experimental herbicide in low maintenance turf. XE-1019 caused injury and reduced height of both common bermudagrass and tall fescue (Tables 14 and 15). Injury to common bermudagrass was greater than to tall fescue. XE-1019 + MSMA caused greater injury, especially at the earliest rating date (2 weeks after treatment) and the last rating date (11 weeks after treatment). Johnsongrass control was better than dallisgrass control with

Table 7. Winter broadleaf control with 2,4-D combinations at six weeks after treatment[1].

Treatment	Rate lb ai/A	% Weed control[2]					
		White clover		Mouseear chickweed		Dandelion	
		No	Yes	No	Yes	No	Yes
Banvel	0.10	60	68	18	15	0	33
Scepter	0.125	18	28	75	78	0	33
Scepter	0.25	20	10	15	25	0	10
Scepter	0.063	3	0	10	20	0	0
Scepter	0.031	0	0	0	0	0	0
Scepter	0.016	3	5	5	13	20	20
Glean	0.063	70	75	75	80	63	70
Glean	0.031	35	43	48	53	43	43
Glean	0.016	23	43	40	45	83	83
Glean	0.008	23	50	13	35	35	40
Glean	0.004	3	13	18	18	35	35
Classic	0.063	70	75	43	55	53	55
Classic	0.031	43	58	38	25	28	48
Classic	0.016	43	48	5	0	15	30
Classic	0.008	0	0	0	0	0	10
Classic	0.004	0	18	0	0	0	0
Ally	0.063	85	88	88	90	88	90
Ally	0.031	90	90	85	83	60	85
Ally	0.016	83	88	48	80	40	60
Ally	0.008	75	83	53	50	63	73
Ally	0.004	90	90	25	25	43	43
LSD (0.05)		31		36		28	
Coefficient of variability		54		77		219	

[1] Conducted at MAFES Plant Science Research Center. Two-way whole split plot design.
[2] With (Yes) or without (No) 1 lb/A 2,4-D.

Table 8. Turfgrass tolerance to BAS 514[1].

Turfgrass	Treatment	Rate lb ai/A	% Turfgrass Injury[2] 9 DAT	15 DAT	21 DAT	51 DAT
Common centipedegrass	BAS 514	0.5	20	20	28	3
	BAS 514	1.0	25	25	40	10
	BAS 514	2.0	35	33	58	25
	Poast	0.5	0	13	0	0
	+ COC[3]	1.3%				
	LSD (0.5)		15	16	18	8
	Coefficient of variability		59	59	46	69
Common bermudagrass	BAS 514	0.5	0	0	0	0
	BAS 514	1.0	3	0	18	0
	BAS 514	2.0	3	5	25	0
	Poast	0.5	25	10	90	25
	+ COC[3]	1.3%				
	LSD (0.05)		5	4	4	9
	Coefficient of variability		54	86	51	22
Tifway bermudagrass	BAS 514	0.5	0	5	0	0
	BAS 514	1.0	5	20	0	0
	BAS 514	2.0	10	23	0	0
	Poast	0.5	10	65	23	0
	+ COC[3]	1.3%				
	LSD (0.5)		8	4	11	3
	Coefficient of of variability		99	52	31	50

[1] Conducted at MAFES Plant Science Research Center. Initiated Sept. 4, 1985.
[2] DAT = Days after treatment.
[3] COC = Crop oil concentrate (Booster Plus E®).

Table 9. Weed control with BAS 514 in three turfgrasses[1].

Turfgrass	Treatment	Rate lb ai/A	% Crabgrass control[2] 9 DAT	15 DAT	30 DAT	51 DAT
Common centipedegrass	BAS 514	0.5	45	63	53	53
	BAS 514	1.0	55	68	70	55
	BAS 514	2.0	50	83	85	75
	Poast	0.5	38	70	70	63
	+ COC[3]	1.3%				
	LSD (0.5)		8	15	3	19
	Coefficient of variability		13	17	33	25
Common bermudagrass	BAS 514	0.5	30	53	70	20
	BAS 514	1.0	48	73	70	48
	BAS 514	2.0	60	83	78	68
	Poast	0.5	45	88	65	45
	+ COC[3]	1.3%				
	LSD (0.5)		9	11	10	13
	Coefficient of variability		15	7	7	23
Tifway bermudagrass	BAS 514	0.5	25	50	0	23
	BAS 514	1.0	40	58	20	53
	BAS 514	2.0	48	65	23	65
	Poast	0.5	38	78	23	35
	+ COC[3]	1.3%				
	LSD (0.5)		10	16	21	NS
	Coefficient of variability		22	20	39	183

[1] Conducted at MAFES Plant Science Research Center. Initiated on Sept. 4, 1985.
[2] DAT = Days after treatment.
[3] COC = Crop oil concentrate (Booster Plus E®).

Table 10. Broadleaf weed control with BAS 514 in three turfgrasses[1].

			% Weed control[2]			
			Slender aster	Dandelion		White clover
Turfgrass	Treatment	Rate lb ai/A	51 DAT	51 DAT	78 DAT	78 DAT
Common centipedegrass	BAS 514	0.5		90	85	80
	BAS 514	1.0		90	90	85
	BAS 514	2.0		90	90	90
	Poast + COC[3]	0.5 1.3%		28	30	23
	Check	0		0	18	33
	LSD (0.5)			22	27	43
	Coefficient of variability			24	28	45
Common bermudagrass	BAS 514	0.5	85	85	35	
	BAS 514	1.0	98	90	85	
	BAS 514	2.0	100	90	90	
	Poast + COC[3]	0.5 1.3%	0	0	0	
	Check	0	0	0	0	
	LSD (0.5)		7	4	2	
	Coefficient of variability		8	5	27	
Tifway bermudagrass	BAS 514	0.5	75	78	50	70
	BAS 514	1.0	93	90	88	90
	BAS 514	2.0	93	90	90	90
	Poast + COC[3]	0.5 1.3%	73	0	8	28
	Check	0	0	0	13	35
	LSD (0.5)		15	7	3	4
	Coefficient of variability		16	8	20	44

[1] Conducted at MAFES Plant Science Research Center. Initiated Sept. 4, 1985.
[2] DAT = Days after treatment.
[3] COC = Crop oil concentrate (Booster Plus E®).

Table 11. Crabgrass control and Raleigh St. Augustinegrass tolerance to Asuloc and atrazine[1]

		% Control[2] smooth crabgrass		% Injury-St.[2] Augustinegrass	
Treatment	Rate lb ai/A	11 DAT	25 DAT	11 DAT	25 DAT
Asulox	1.5	80	0	0	0
Asulox	2.0	83	85	8	0
Asulox	2.5	78	83	5	0
Asulox + atrazine	1.5 1.5	90	88	10	0
Asulox + atrazine	2.0 1.5	78	88	3	0
Asulox + atrazine	2.5 1.5	90	83	10	0
LSD (0.5)		17	8	NS	NS
Coefficient of variability		14	57	146	0

[1] Conducted at Pearl River Valley Turf Farm. Initiated July 19, 1985.
[2] DAT = Days after treatment.

Table 12. Evaluation of 2,4-D mixtures for Virginia buttonweed control in common bermudagrass[1].

Treatment	Rate[2] 2,4-D lb ai/A	% Control[3] Virginia buttonweed				% Injury[3] bermudagrass turf		
		7 DAT	14 DAT	25 DAT	39 DAT	14 DAT	25 DAT	39 DAT
EH 680[4]	0.75	40	70	90	68	10	20	0
EH 791[5]	0.91	38	63	80	43	10	18	0
EH 553[6]	1.00	30	55	63	48	10	13	0
EH 637[7]	0.68	40	70	80	45	10	25	0
DPC[8]	0.93	33	63	75	48	10	23	0
Check		0	0	0	0	0	0	0
LSD (0.05)		4	7	7	3	NS	NS	10
Coefficient of variability		9	9	8	48	0	0	41

[1] Conducted Live Oaks Country Club. Initiated Aug. 1, 1985.
[2] Rate is 2,4-D rate in the mixture (EH series and DPC).
[3] DAT = Days after treatment.
[4] Mixture of 2.0 lb 2,4-D ester + 2.0 lb dichlorprop ester + 0.5 lb Banvel per gallon (Super Trimec).
[5] Mixture of 2.43 lb 2,4-D amine + 1.21 lb mecoprop amine + 0.24 lb Banvel per gallon.
[6] Mixture 2.03 lb 2,4-D + 1.08 lb mecoprop amine + 0.21 lb Banvel amine per gallon (Trimec).
[7] Mixture 3.35 lb 2,4-D amine + 1.13 lb mecoprop amine + 0.14 lb Banvel per gallon.
[8] Weedone DPC, 1.85 + 1.85 lb/gallon of 2,4-D + dichlorprop.

Table 13. Evaluation of Quadmec and Trimec plus MSMA in common bermudagrass turf[1].

Treatment	Rate [3] lb ai/A	No. of Applications	% Turf injury[2]		% Goosegrass control[2]	
			14 DAIT	42 DAIT	14 DAIT	42 DAIT
Quadmec + X-77	0.53 0.25%	1	3	20	3	18
Quadmec + X-77	0.53 0.25%	2	25	26	40	53
Trimec + MSMA + X-77	0.64 2.00 0.25%	1	8	20	10	18
Trimec + MSMA + X-77	0.64 2.00 0.25%	2	8	33	20	35
MSMA + X-77	2.00 0.25%	1	0	18	3	10
MSMA + X-77	2.00 0.25%	2	5	10	13	18
LSD (0.05)			9	22	18	19
Coefficient of variability			76	69	83	50

[1] Conducted at Mississippi State Univ. Golf Course. Initiated July 26, 1985 with second of two treatments being made Aug. 2, 1985.
[2] DAIT = Days after initial treatment.
[3] Rate given is the 2,4-D rate in the mixture Quadmec and Trimec.

Table 14. Evaluation of XE 1019 in low maintenance bermudagrass turf[1].

Treatment	Rate lb ai/A	Bermudagrass[2] % injury 2 WAT	4 WAT	6 WAT	8 WAT	11 WAT	Height inches 11 WAT
XE 1019	0.5	8	10	10	15	5	12.8
XE 1019	1.0	5	15	18	35	25	8.8
XE 1019	2.0	5	15	33	45	45	5.5
XE 1019 + MSMA + X-77	0.5 3.0 0.25%	23	15	25	10	33	7.5
XE 1019 + MSMA + X-77	1.0 3.0 0.25%	25	20	25	15	43	7.0
XE 1019 + MSMA + X-77	2.0 3.0 0.25%	35	28	48	35	75	3.3
MSMA + X-77	3.0 0.25%	32	13	3	0	0	16.8
Check		0	0	0	5	0	11.8
LSD (0.05)		12	10	21	11	16	3.8
Coefficient of variability		48	48	61	38	39	28

[1] Conducted at MAFES Plant Science Research Center. Initiated on June 25, 1985.
[2] WAT = Weeks after treatment.

Table 15. Evaluation of XE 1019 in low maintenance bermudagrass turf[1].

Treatment	Rate lb ai/A	Tall fescue[2] % injury 2 WAT	4 WAT	6 WAT	8 WAT	11 WAT	Height inches 11 WAT
XE 1019	0.5	0	5	5	0	3	19.5
XE 1019	1.0	0	8	10	0	13	12.3
XE 1019	2.0	0	10	10	0	23	9.5
XE 1019 + MSMA + X-77	0.5 3.0 0.25%	5	10	8	15	8	20.0
XE 1019 + MSMA + X-77	1.0 3.0 0.25%	8	10	5	3	10	21.5
XE 1019 + MSMA + X-77	2.0 3.0 0.25%	8	10	13	0	23	9.8
MSMA + X-77	3.0 0.25%	5	8	5	5	0	25.0
Check		0	0	0	10	0	20.8
LSD (0.05)		6	4	5	NS	7	5.1
Coefficient of variability		129	41	62	297	52	20

[1] Conducted at MAFES Plant Science Research Center. Initiated on June 25, 1985.
[2] 2WAT = Weeks after treatment.

Table 16. Evaluation of XE 1019 in low maintenance bermudagrass turf[1].

Treatment	Rate lb ai/A	% Johnsongrass control[2]				
		2 WAT	4 WAT	6 WAT	8 WAT	11 WAT
XE 1019	0.5	10	34	65	30	13
XE 1019	1.0	1	34	60	25	50
XE 1019	2.0	14	45	78	50	78
XE 1019	0.5	51	80	83	63	53
+ MSMA	3.0					
+ X-77	0.25%					
XE 1019	1.0	42	85	83	38	58
+ MSMA	3.0					
+ X-77	0.25%					
XE 1019	2.0	45	70	90	73	90
+ MSMA	3.0					
+ X-77	0.25%					
MSMA	3.0	47	36	73	40	13
+ X-77	0.25%					
Check		0	13	0	20	0
LSD (0.05)		27	28	17	37	36
Coefficient of variability		62	37	17	59	57

[1] Conducted at MAFES Plant Science Research Center. Initiated on June 25, 1985.
[2] WAT = Weeks after treatment.

Table 17. Evaluation of XE 1019 in low maintenance bermudagrass turf[1].

Treatment	Rate lb ai/A	% Dallisgrass control[2]				% Foxtail control[2]
		2 WAT	4 WAT	6 WAT	8 WAT	11 WAT
XE 1019	0.5	0	0	28	13	33
XE 1019	1.0	0	0	43	18	75
XE 1019	2.0	0	0	60	33	88
XE1019	0.5	10	50	50	83	38
+ MSMA	3.0					
+ X-77	0.25%					
XE 1019	1.0	5	43	60	90	88
+ MSMA	3.0					
+ X-77	0.25%					
XE 1019	2.0	3	45	83	90	90
+ MSMA	3.0					
+ X-77	0.25%					
MSMA	3.0	3	45	45	58	0
+ X-77	0.25%					
Check		0	0	0	0	0
LSD (0.05)		8	5	18	33	26
Coefficient of variability		25	118	26	48	35

[1] Conducted at MAFES Plant Science Research Center. Initiated on June 25, 1985.
[2] WAT = Weeks after treatment.

XE-1019 applied with MSMA (Tables 16 and 17). XE-1019 + MSMA gave better control of both johnsongrass and dallisgrass than when XE-1019 was applied alone.

Effect of Frigate on Activity of Roundup

This study was designed to evaluate Frigate as an additive to Roundup for control of common bermudagrass (Table 18). Neither X-77® or Frigate at 0.5% by volume increased the control of bermudagrass in this study as compared to Roundup without surfactant added. Eighty percent or higher control of bermudagrass was observed with all treatments containing Roundup. No consistent differences in control of smooth crabgrass or white clover were observed due to additive.

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Table 18. Effect of additives on bermudagrass control with Roundup[1].

Roundup Rate lb ai/A	Additive @ 0.5%[2]	% Bermudagrass control[3]				% Smooth crabgrass control[3]		% White clover control[3]	
		1 WAT	3 WAT	5 WAT	7 WAT	1 WAT	3 WAT	1 WAT	3 WAT
0	None	0	0	0	0	0	23	0	20
4.0	None	35	73	80	90	70	90	44	78
4.0	Frigate	28	68	80	85	48	90	27	78
4.0	X-77	33	58	80	90	55	68	33	65
3.0	None	28	70	80	85	53	90	30	80
3.0	Frigate	23	65	80	85	63	90	37	85
3.0	X-77	25	73	78	83	65	90	43	85
LSD (0.05)		7	9	3	8	11	25	15	10
Coefficient of variability		20	11	3	8	15	22	32	9

[1] Conducted at MAFES Plant Science Research Center. Initiated on Aug. 13, 1985.
[2] Additive concentration by volume in 25 gallons per acre application volume.
[3] WAT = Weeks after treatment.

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Response of Cotton to Selected Herbicides Applied to Simulate Drift

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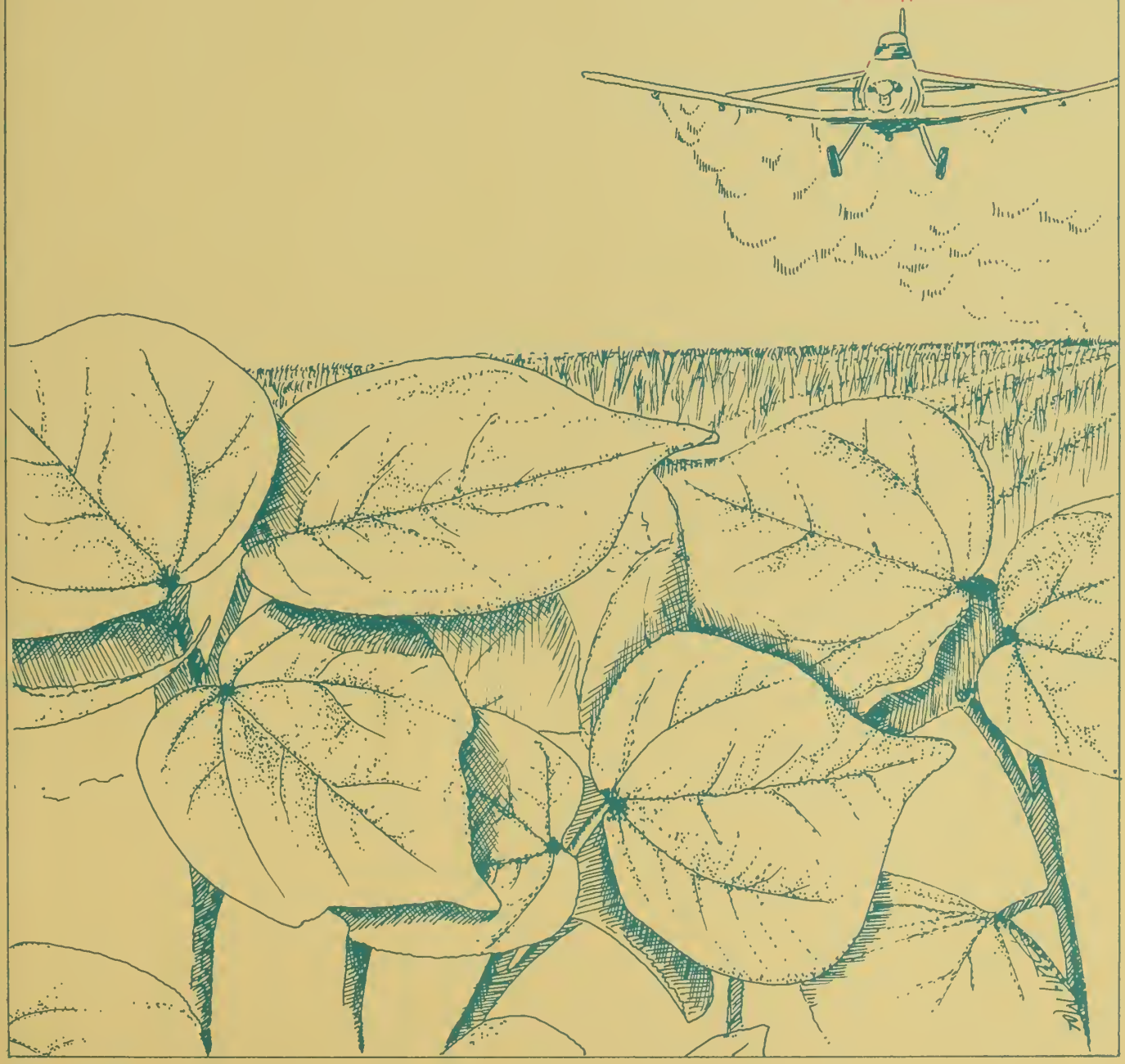

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Response of Cotton to Selected Herbicides Applied to Simulate Drift

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Response of Cotton to Selected Herbicides Applied to Simulate Drift

Introduction

In the Mississippi Delta, many rice and soybean fields are located adjacent to or near cotton fields. Thus, herbicides used for weed control in rice and soybeans may contact cotton plants by drift or by accidental direct application. Affected cotton plants may be injured or killed by such herbicides (used in rice and soybeans) as propanil (Stam® and other brands), metribuzin (Lexone® and Sencor®), and acifluorfen (Blazer®; Tackle®). Herbicides which are likely replacements for 2,4,5-T for broadleaf weed control in rice are bromoxynil (Brominal®, Buctril®), MCPA Amine (several brands), and 2,4-D (several brands). These are also potentially harmful to cotton plants.

Several studies have shown that cotton plants can be injured by early season applications of herbicides applied over-the-top (1, 3, 4, 5, 6, 7, 8). A Louisiana study (2) reported that yields were not reduced from applications of acifluorfen on six- to seven-leaf cotton (48 days after planting) at rates up to 0.08 pound active ingredient (ai) per acre. Applications of acifluorfen to cotton plants at early-bloom (early July) at rates up to 0.16 lb ai/A did not reduce cotton yields in the Louisiana study; applications of 0.16 lb ai/A to cotton at mid-bloom (late July) reduced yields, but rates of 0.08 lb ai/A and below had no effect.

The objectives of the studies reported here were to measure stands and yields of cotton when selected herbicides were applied over-the-top to cotton fields in the Mississippi Delta.

Materials and Methods

Experiments were conducted at the Mississippi Agricultural and Forestry Experiment Station Delta Branch during the 3-year period 1980-1982. A randomized complete block design with three (1980) or four (1981 and 1982) replications was used. Soil was a silt loam; 33.2% sand, 49.2% silt, 17.6% clay, 1.1% organic matter, 5.8 pH in 1980; 37.0% sand, 51.4% silt, 11.6% clay, 0.4% organic matter, 6.2 pH in 1981; and 32.3% sand, 49.4% silt, 18.3% clay, 1.0% organic matter, and 6.6 pH in 1982.

Individual plots were three (1980) or four (1981 and 1982) 40-inch rows of cotton 40 (1980) or 50 feet long (1981 and 1982).

The 'DES 56' cotton variety was planted April 25, 1980; April 23, 1981; and April 29, 1982. Standard management practices for optimum yields were used. The experimental area was kept weed-free, with standard herbicides applied preplant soil incorporated, surface preemergence, and directed postemergence; plus mechanical cultivation and hand hoeing.

All over-the-top herbicide treatments were applied with a tractor-mounted boom sprayer using a spray volume of 10 gallons per acre. The boom was positioned so that one flat-fan nozzle was located 10 inches above each cotton row. Applications were made at one of three cotton plant development stages: (a) cotyledonary, (b) three-node, or (c) six- or seven-node stage. The six-node stage was planned, but weather forced a delay in application until cotton plants reached the seven-node stage in 1980 and 1982.

Herbicide treatments are listed in Table 1. Application rate was often adjusted in successive years because of results from applications during previous years. Stands of cotton plants were counted 38 to 126 days after application to cotyledonary cotton, 46 to 105 days after application to cotton at the three-node stage, and 37 to 95 days after application to cotton at the six- or seven-node stage. Seed cotton yields were determined by mechanically harvesting one (1980) or two (1981 and 1982) rows in each plot one time.

In 1982, cotton at the three-node stage treated with 0.25 and 0.375 lb ai/A Blazer 2S or Tackle 2AS was injured to such an extent that replanting was required (a large number of plants were killed). Visually, the maturity of plants from these plots appeared delayed. However, this could not be confirmed as accidental harvest of the entire field occurred before an additional plot harvest could be made. Other treatments in 1982, and all treatments in 1980 and 1981, did not delay cotton maturity as determined by visual observation.

Plots were harvested October 15, 1980, October 20, 1981, and September 20, 1982. Plants from one outside row in each plot were removed 3 days after treatment to obtain plant material for propanil (Stam M4) residue analyses in 1980 and 1981 (data not reported). This was repeated at 10 days after treatment on the other outside row in each plot. Plants for residue determinations were also removed from the same rows in non-propanil treated plots so seed cotton yield could be compared.

Field data on cotton stand are presented as percent

of the original stand in each plot; yield data are presented as percent of the untreated controls. Data were subjected to analysis of variance and means were separated by Duncan's Multiple Range Test at the 5% level.

Results and Discussion

Cotton Stand

All treatments applied to cotyledonary cotton plants reduced the stand in 1980 (Table 1). This was an unusually dry growing season which probably allowed less opportunity for treated plants to recover. Treatments applied to cotyledonary cotton in 1981, which did not reduce stand, were: Blazer 2S at 0.125 lb ai/A, Blazer 2S and Tackle 2AS at 0.25 lb ai/A, and Stam M4 at 0.03125 and 0.0625 lb ai/A. Natural mortality of plants in 1981 was high, resulting in a 27% stand reduction in the untreated control. In 1982, no herbicide treatment reduced the stand below that of the untreated control when applied to cotyledon-stage cotton plants.

The application of propanil (Stam M4, Stam 4F) to three-node cotton plants did not reduce stand in any year when compared with the untreated controls. When propanil was applied to six- or seven-node cotton plants, Stam M4 at 0.125 lb ai/A in 1980 reduced the stand when compared to the untreated controls. However, an increase in stand resulted in plots with this treatment in 1981.

Concurrent with cultivation of the plot area on June 2, 1982, a 16-inch band application of fluometuron (Cotoran® 80W) plus MSMA was made directed to the base of cotton plants at a broadcast rate of 0.8 + 1.6 lb ai/A. This was 9 days after the three-node simulated drift treatments were applied. From field observation on June 4, it was very apparent that plants previously treated at the three-node stage with propanil (Stam M4) had considerably greater injury symptoms than plants which had not been treated. Pronounced injury symptoms did not occur with plants surviving the cotyledonary stage treatments or with plants treated at the seven-node stage. Treatments to seven-node cotton were made 40

Table 1. The effect of simulated drift from selected herbicides on the stand of cotton when applied at three plant growth stages. MAFES, Delta Branch, Stoneville, MS, 1980-1982.

		Cotton growth stage at treatment[1], [2]								
	Rate	Cotyledon			3-Node			6- or 7-Node		
Herbicide	(lb ai/A)	1980	1981	1982	1980	1981	1982[3]	1980	1981	1982
		Stand counts (%)[4]			Stand counts (%)[4]			Stand counts (%)[4]		
PROPANIL (Common name)										
Stam M4®	0.03125	----------	73.8 a	134.9 a	----------	62.0 a	----------	----------	----------	----------
Stam M4	0.0625	41.7 bc	60.2 abc	86.7 ab	89.0 a	65.6 a	79.6 ab	----------	112.9 ab	105.7 ab
Stam M4	0.125	55.7 b	51.3 cde	73.0 b	87.3 a	67.9 a	82.3 ab	70.0 b	123.3 a	90.0 b
Stam M4	0.25	----------	34.5 e	----------	----------	59.5 a	101.8 ab	84.3 ab	106.6 abc	100.2 ab
Stam M4	----------	----------	----------	----------	----------	----------	----------	----------	98.4 bc	----------
Stam 4F	0.125	55.7 b	44.9 cde	----------	90.0 a	69.2 a	----------	----------	----------	----------
Stam 4F	0.25	----------	38.4 de	----------	----------	70.1 a	----------	93.3 a	112.2 ab	----------
Stam 4F	0.375	----------	----------	----------	----------	----------	----------	----------	114.2 ab	----------
ACIFLUORFEN (Common name)										
Blazer 2S®	0.0625	----------	----------	131.1 a	----------	----------	----------	----------	----------	----------
Blazer 2S	0.125	39.7 bc	57.4 a-d	64.1 b	----------	----------	114.0 a	----------	----------	118.4 a
Blazer 2S	0.25	35.0 bc	52.6 b-e	64.8 b	77.0 a	56.7 ab	84.8 ab	----------	----------	107.4 ab
Blazer 2S	0.375	----------	----------	----------	82.0 a	36.4 b	92.2 ab	86.0 ab	100.6 bc	103.2 ab
Blazer 2S	0.50	----------	----------	----------	----------	----------	----------	88.7 ab	95.1 c	----------
Tackle 2AS®	0.0625	----------	----------	115.3 ab	----------	----------	----------	----------	----------	----------
Tackle 2AS	0.125	----------	----------	94.5 ab	----------	----------	69.7 b	----------	----------	105.4 ab
Tackle 2AS	0.25	----------	53.7 a-e	----------	----------	----------	92.1 ab	----------	----------	88.6 b
Tackle 2AS	0.375	----------	----------	----------	----------	48.1 ab	85.3 ab	----------	----------	111.6 ab
Tackle 2AS	0.50	----------	----------	----------	----------	----------	----------	----------	103.2 bc	----------
UNTREATED	----------	86.0 a	73.3 ab	98.5 ab	82.7 a	69.6 a	83.8 ab	99.0 a	101.2 bc	102.1 ab
ORIGINAL PLANTS/A (in thousands)		(50.0)	(58.9)	(43.8)	(44.4)	(60.4)	(38.6)	(47.6)	(56.6)	(40.6)

[1] Expressed as % of original stand; calculated from counts made before and after treatment.

[2] Values in the same column followed by the same letter are not significantly different (P = .05) according to Duncan's Multiple Range Test.

[3] Treatments with Blazer 2S and Tackle 2AS at 0.25 and 0.375 lb/A were replanted June 4, 1982 because of excessive stand reduction brought about by a very light rain shower (just enough to wet leaves) 40 minutes after application and again at 19 hours after application. Treatments with Blazer 2S and Tackle 2AS at 0.125 lb/A were injured severely but plants recovered.

[4] Percent of the original plants.

minutes after the directed postemergence application of fluometuron + MSMA. In 1982, fluometuron was also applied preemergence to a 16-inch band over the row at planting at a broadcast rate of 1.0 lb ai/A. The greater injury symptoms with propanil treatments applied to three-node cotton plants in 1982 did not adversely affect subsequent cotton yield (Table 2).

Blazer 2S applied at 0.375 lb ai/A to three-node cotton plants was the only acifluorfen treatment which reduced stand in 1981 (Table 1). However, treatments of Blazer 2S and Tackle 2AS at all rates applied to three-node plants in 1982 injured cotton severely. The severe injury occurred because of light rains (just enough to wet plant leaves) 40 minutes after application and again about 19 hours after application. The rates of 0.25 and 0.375 lb ai/A resulted in plant injury and death (96 to 99% stand reduction) sufficient to require replanting June 4. Cotton stand with the second planting was not affected. The treatments with 0.125 lb ai/A produced severe injury and delayed plant growth, but surviving plants produced an adequate stand. The values in Table 1 represent the final stand. No acifluorfen treatment reduced stand when applied to six- or seven-node cotton plants.

Cotton Yields

Seed cotton yields were greater overall in 1980 and 1981 because of the final plot row configuration in these studies. After plants were removed for propanil analysis, the field had an alternating pattern of one row of cotton and two skip rows in 1980 and a two cotton-two skip row pattern in 1981. This allowed the cotton plants to have access to greater amounts of soil moisture and nutrients and greater sunlight penetration. Therefore, to allow better comparisons between treated and untreated plots through all years, yields are expressed as a percent of the untreated control.

In 1980, all propanil treatments reduced yield when

Table 2. The effect of simulated drift from selected herbicides on seed cotton yield when applied to cotton plants at three growth stages. MAFES Delta Branch, Stoneville, MS, 1980-1982.

		Cotton growth stage at treatment[1], [2]								
	Rate	Cotyledon			3-Node			6- or 7-Node		
Herbicide	(lb ai/A)	1980	1981	1982	1980	1981	1982[3]	1980	1981	1982
		Yield (%)[4]			Yield (%)[4]			Yield (%)[4]		
PROPANIL (Common name)										
Stam M4®	0.03125	----------	105 ab	93 a	----------	107 a	----------	----------	----------	----------
Stam M4	0.0625	43 bcd	102 ab	102 a	98 a	103 ab	92 b	----------	93 abc	100 ab
Stam M4	0.125	65 bc	92 bc	102 a	93 a	92 bcd	108 a	113 a	89 bc	101 ab
Stam M4	0.25	----------	85 c	----------	----------	95 abc	102 ab	96 abc	94 abc	92 c
Stam M4	0.375	----------	----------	----------	----------	----------	----------	----------	78 d	----------
Stam 4F	0.125	56 bcd	107 ab	----------	93 a	94 abc	----------	----------	----------	----------
Stam 4F	0.25	----------	93 abc	----------	----------	99 ab	----------	103 ab	97 ab	----------
Stam 4F	0.375	----------	----------	----------	----------	----------	----------	----------	89 bc	----------
ACIFLUORFEN (Common name)										
Blazer 2S®	0.0625	----------	----------	97 a	----------	----------	----------	----------	----------	----------
Blazer 2S	0.125	74 ab	108 a	100 a	----------	----------	59 c	----------	----------	102 a
Blazer 2S	0.25	55 bcd	97 abc	102 a	99 a	82 cde	14 d	----------	----------	96 bc
Blazer 2S	0.375	----------	----------	----------	89 a	80 de	10 d	79 c	89 bc	93 c
Blazer 2S	0.50	----------	----------	----------	----------	----------	----------	101 ab	86 cd	----------
Tackle 2AS®	0.0625	----------	----------	101 a	----------	----------	----------	----------	----------	----------
Tackle 2AS	0.125	----------	----------	101 a	----------	----------	92 b	----------	----------	97 abc
Tackle 2AS	0.25	----------	94 abc	----------	----------	----------	12 d	----------	----------	101 ab
Tackle 2AS	0.375	----------	----------	----------	----------	78 e	13 d	----------	----------	100 ab
Tackle 2AS	0.50	----------	----------	----------	----------	----------	----------	----------	93 abc	----------
UNTREATED	----------	100 a	100 abc	100 a	100 a	100 ab	100 ab	100 ab	100 a	100 ab
(lb/A seed cotton)		(4,552)	(2,879)	(2,987)	(4,182)	(3,215)	(2,463)	(3,714)	(3,702)	(2,919)

[1] Yield is expressed as % of untreated controls; the yield is greater than normal in 1980 and 1981 because one row on each side of the harvest rows was removed in early season for herbicide residue determinations. The field was accidentally harvested in 1982 before a second plot harvest could be obtained.

[2] Values within the same column followed by the same letter are not significantly different (P = .05) according to Duncan's Multiple Range Test.

[3] Treatments with Blazer 2S and Tackle 2AS at 0.25 and 0.375 lb/A were replanted June 4, 1982 because of excessive stand reduction brought about by a very light rain shower (just enough to wet leaves) 40 minutes after application and again at 19 hours after application. Treatments with Blazer 2S and Tackle 2AS at 0.125 lb/A were injured severely but plants recovered.

[4] Percent of untreated plot yields.

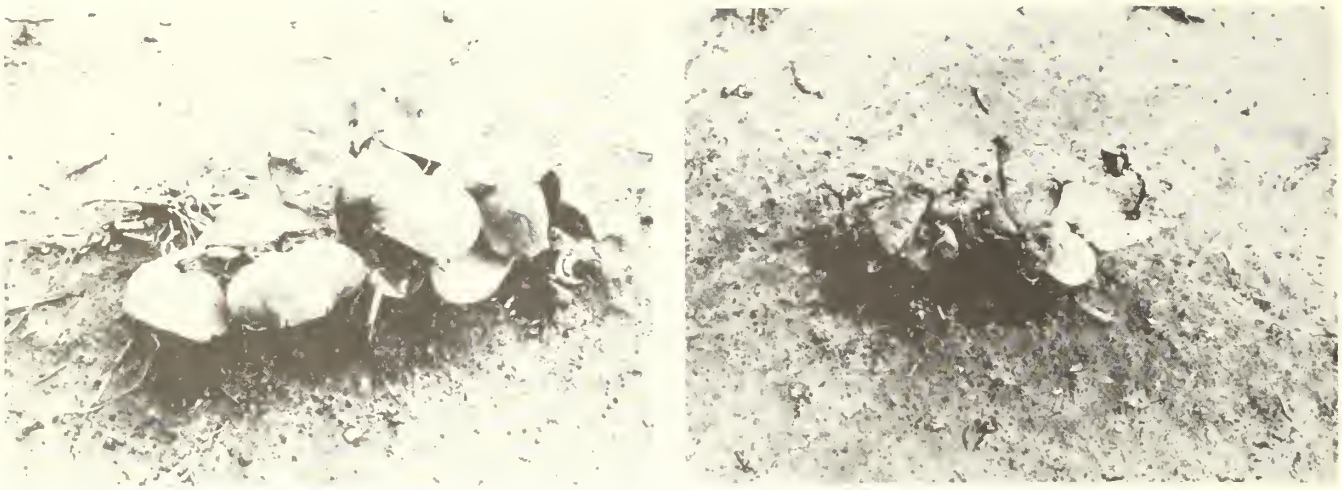

Figure 1. Cotton plant at left is the untreated control. The plant at right is shown 10 days after treatment with 0.25 lb/A of Blazer 2S at the cotyledon stage of growth.

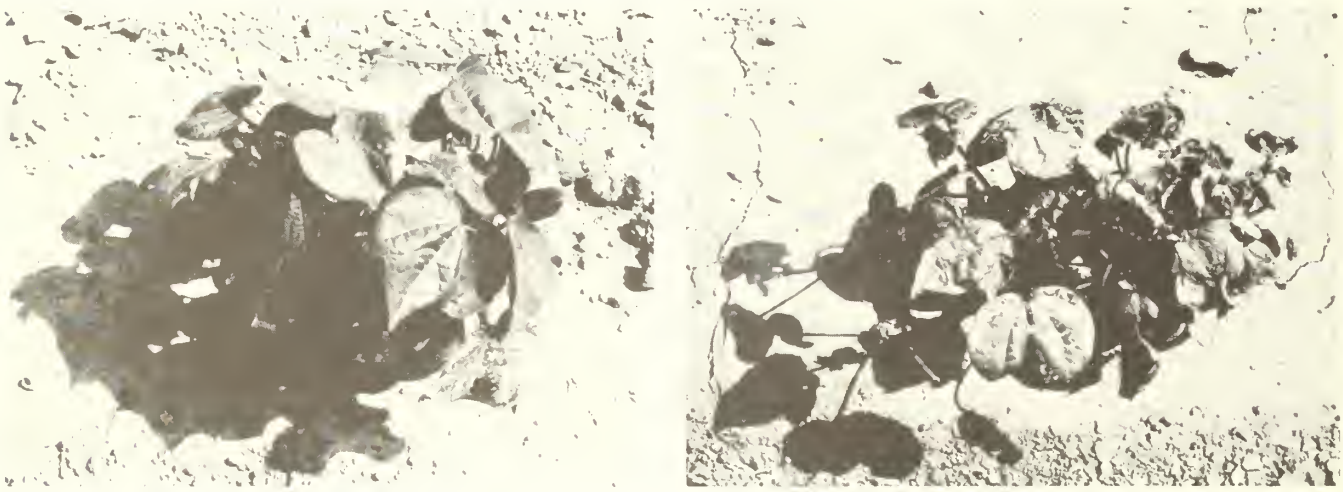

Figure 2. Cotton plant at left is the untreated control. The plant at the right is shown 3 days after treatment with 0.25 lb/A of Blazer 2S at the three-node stage of growth.

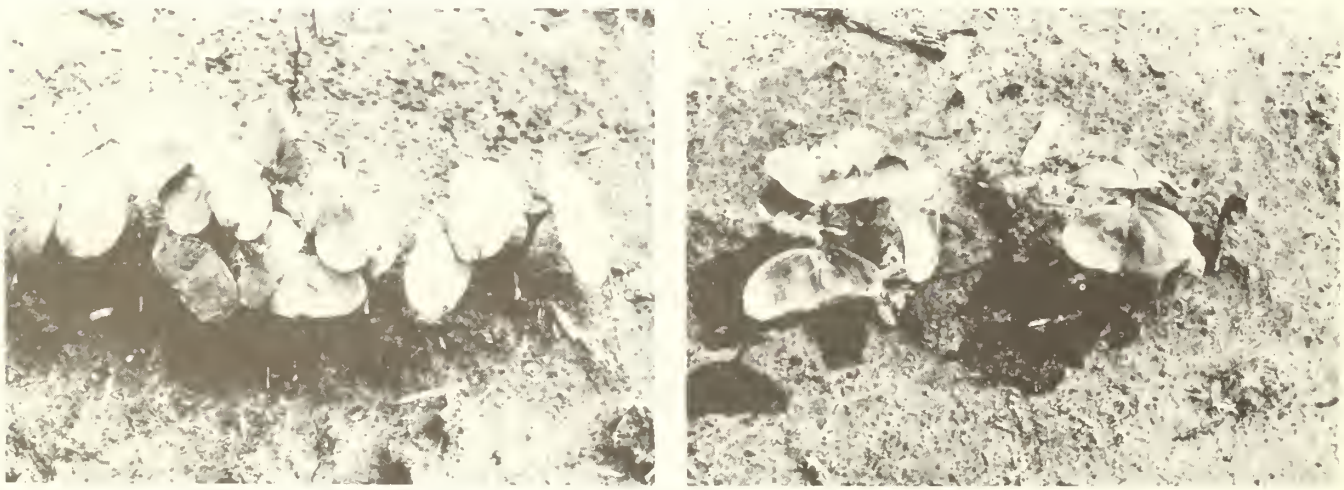

Figure 3. Cotton plant at left is the untreated control. The plant at the right is shown 10 days after treatment with 0.0625 lb/A of Stam M4 at the cotyledon stage of growth.

Figure 4. Cotton plant at left is the untreated control. The plant at right is shown 10 days after treatment with 0.0625 lb/A of Stam 4S at the three-node stage of growth.

Figure 5. Cotton plant at left is the untreated control. The plant at the right is shown 10 days after treatment with 0.25 lb/A of Stam M4 at the three-node stage of growth.

Figure 6. Cotton plant at left is the untreated control. The plant at the right is show 7 days after treatment with 0.25 lb/A of Stam M4 at the three-node stage of growth.

Table 3. A comparison of herbicide rates normally used for weed control and seed cotton yield reductions in simulated drift studies at the MAFES Delta Branch, Stoneville, MS, 1980-1982.

Herbicide	Rate for weed control		Rate required to reduce seed cotton yield		
	Rice	Soybeans	Cotyledon	3-Node	6- or 7-Node
	(lb ai/A)		(lb ai/A)		
Propanil	3-6	NR[1]	0.0625	N[2]	0.375
Acifluorfen	0.125	0.375-0.5	0.25	0.125[3]	0.375

[1] NR = Not registered for use.
[2] N = No effect at the rates applied.
[3] Only occurred with unusual rainfall conditions; otherwise, 0.25 lb ai/A was required.

compared to the untreated control. This was probably due to the extreme dry weather in the 1980 growing season. Cotton plants never fully recovered from the early propanil injury and stand reduction. Propanil (Stam M4, Stam 4F) applied to cotyledonary cotton plants did not affect seed cotton yield in 1981 or 1982 (Table 2). There was a trend for lower yield as rate increased in 1981.

Acifluorfen (Blazer 2S, Tackle 2AS) applied to cotyledonary cotton plants did not reduce yield in 1981 and 1982. In 1980, yield was reduced only by Blazer 2S at 0.25 lb ai/A.

When applied to three-node cotton plants, propanil (Stam M4, Stam 4F) treatments did not reduce yield in any year when compared with the untreated control (Table 2). Acifluorfen (Blazer 2S) applied to three-node cotton plants in 1980 did not reduce yields from those of the untreated control (Table 2). However, these same treatments, and Tackle 2AS at the higher rate applied in 1981, reduced seed cotton yields by 18 to 22%. In 1982, acifluorfen applied to three-node cotton plants produced severe injury under the conditions previously described. Very low yields resulted from the replanted plots (Table 2). The entire field was accidentally harvested before a second plot harvest was made. Plots treated with Blazer 2S and Tackle 2AS at 0.125 lb ai/A were not replanted. With these treatments, Blazer 2S yielded 33% less than Tackle 2AS.

When propanil (Stam M4, Stam 4F) was applied to six- or seven-node cotton plants, yield was reduced by Stam M4 and Stam 4F at 0.375 lb ai/A in 1981, and by Stam M4 at 0.125 lb ai/A in 1981 and at 0.25 lb ai/A in 1982 (Table 2). Acifluorfen applied to six- or seven-node cotton plants as Tackle 2AS at 0.5 lb ai/A in 1981, or at 0.125 to 0.375 lb ai/A in 1982, did not affect yield. When applied as Blazer 2S, yield was reduced from the application of 0.375 lb ai/A in 1980, 1981, and 1982 and 0.5 lb ai/A in 1981.

Summary

Selected rice and soybean herbicides were applied to cotton plants at three growth stages in a manner designed to simulate drift or accidental direct application. Cotton stand was reduced when applications of herbicides were made during years of poor growing conditions. Injury was greatest from applications to cotton plants in the cotyledon stage of development. Cotton stand was not reduced when applications of herbicides were made to three-node (except in 1982 with acifluorfen) or to six- or seven-node plants, except when the rates were excessively high.

Seed cotton yields were reduced during 1980, a year of extremely low rainfall. Yields were reduced when herbicides were applied to cotyledonary cotton plants. Table 3 summarizes the rate required to reduce seed cotton yields. From these results, the order of toxicity to cotyledonary cotton is propanil greater than acifluorfen. When applied to three-node plants, the acifluorfen is more toxic than propanil. The toxicity of chemicals applied to six- or seven-node cotton plants the same (propanil is equal to acifluorfen).

Table 3 also includes the herbicide application rates normally used to control weeds. It is apparent that with herbicides in these studies, seed cotton yields can be reduced with propanil at 1 to 12% of the normal use rate and 33 to 133% the normal rate of acifluorfen applied to soybeans or 100 to 300% the normal rate for rice. From these comparisons, it appears that the overall toxicity to cotton of herbicides used in these studies is that propanil is more toxic than acifluorfen.

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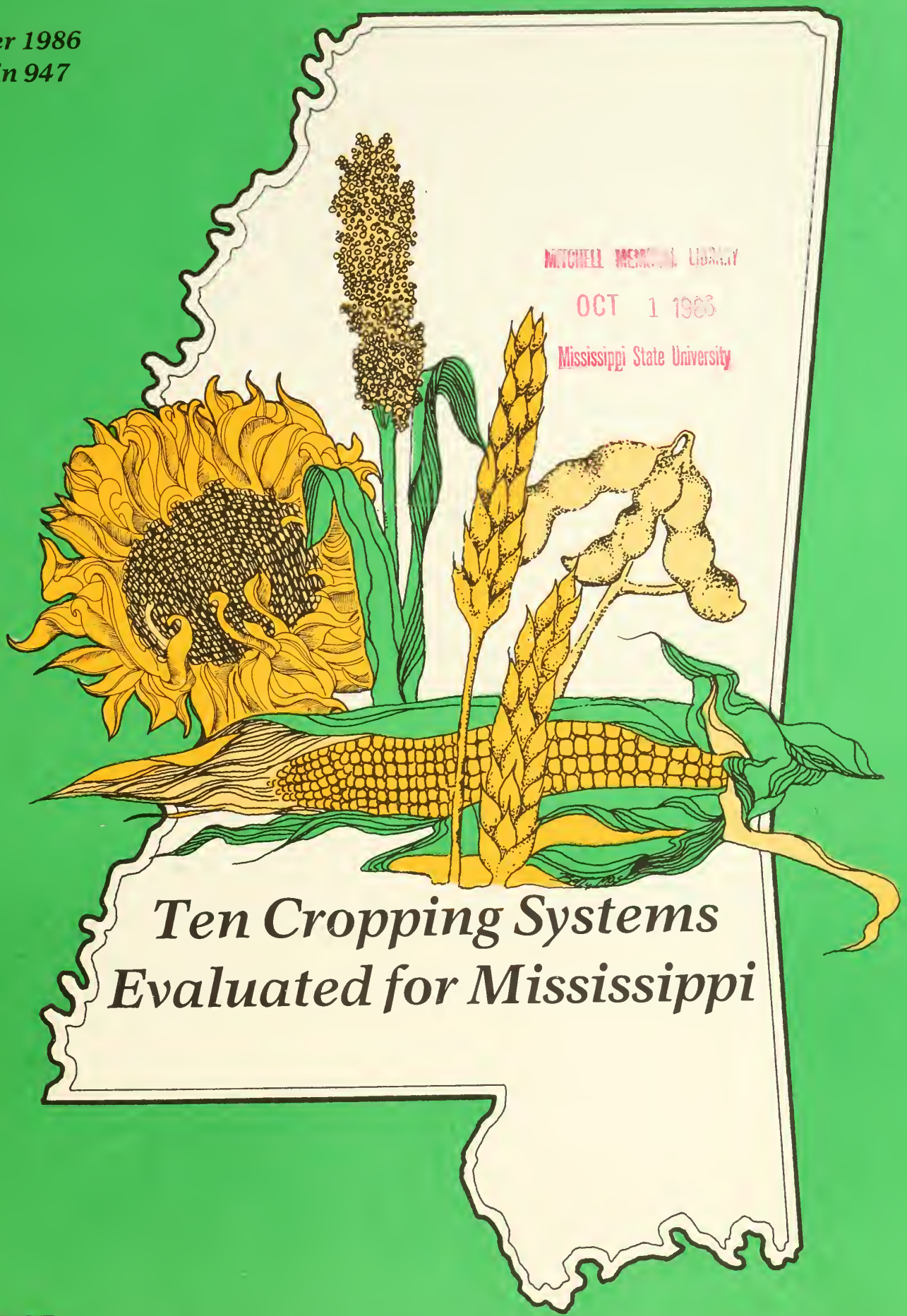

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Ten Cropping Systems Evaluated for Mississippi

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However, few studies have included alternative cropping comparisons. Consequently, there are few economic comparisons of alternatives in the literature. Evaluations of this type would provide a basis for selection of economically feasible alternative crops and production systems in a farming enterprise.

The objectives of this study were: (1) to agronomically and economically evaluate a number of cropping systems (enterprises), and (2) to determine the appropriate farm size and number of acres of each of these enterprises that maximize annual net cash farm income from a representative farm that efficiently utilizes a complement of six-row equipment and machinery.

Materials and Methods

This nonirrigated study was conducted on the MAFES Plant Science Research Center at Mississippi State from 1976 through 1980 on nearly level Leeper silty clay (fine montmorillonitic, nonacid, thermic, Vertic Haplaquept), a bottomland Blackland Prairie soil. The soil was high in P_2O_5 and K_2O (231 and 417 lb/a, respectively), and the pH was 7.1 prior to the study.

There were ten treatments, composed of five monocrop and five doublecrop systems. Monocrops were commercial (C) hybrid corn, soybeans, grain sorghum, oil-type sunflowers, and wheat. Doublecrops consisted of wheat plus the first four monocrops above, and an experimental corn hybrid (Mp4008, developed by the USDA-ARS Corn Host Plant Resistance Research Unit at Mississippi State) which has resistance (R) to fall armyworm [*Spodoptera frugiperda* (J. E. Smith)] and southern corn rust (*Puccinia polysora* Underw.) (12).

Treatments consisting of cropping systems were arranged in randomized block design with four replications. Plots were 20 feet wide and 50 feet long. Monocrops, except for wheat, were planted in rows 40 inches apart with a John Deere® 71 flex planter. Monocrops, including wheat, were planted into prepared seedbeds. Doublecrop summer crops were planted no-till using the same planter equipped with Allis Chalmers® fluted coulters (one per row) after burning the wheat straw. Wheat was planted with a conventional grain drill, with double-disk openers spaced 7 inches apart, except in the soybean/wheat system where wheat was overseeded. Monocrop and doublecrop wheat, except for wheat following soybeans, was seeded Nov. 1-10 at a rate of 90 pounds per acre. Wheat following soybeans was aerially seeded during the first week of October at the same rate.

The study began the fall of 1976 with the seeding of wheat. Yields from this seeding were not used since this wheat was used only to initiate the cropping sequence. Monocrop yields (except wheat) and yields of the summer crops of doublecrop treatments were determined in 1977, 1978, and 1979 while wheat yields (including monocrop) were determined in 1978, 1979, and 1980.

Yields of all row crops, except doublecrop sunflowers, were determined by harvesting the two center rows of each plot using the same combine equipped with an appropriate header. Doublecrop sunflowers were harvested by hand in 1979 because of excessive lodging. Wheat was harvested by combining a 13-foot wide swath through the center of each plot between June 1 and 10. Yields were calculated for corn, soybeans, grain sorghum, sunflowers, and wheat as containing 15.5, 13.5, 13.5, 10.0, and 13.5% moisture, respectively. Wheat yields were statistically analyzed and differences among yields were tested by Duncan's new multiple range test at the 0.05 probability level. Actual production budgets for the enterprises are shown in Appendix Tables 1 through 15.

Monocrop Systems

Monocrops were grown using conventional land preparation and cultivation. Preparation consisted of sufficient chisel plowing and disking in the spring to prepare a seedbed. Land for wheat was prepared in a similar manner in the fall. Seedbeds were harrowed smooth before planting. Practices pertinent to a particular monocrop system are given below.

Corn

Preplant fertilizer containing 58, 58, and 58 lb/a of N, P_2O_5, and K_2O, respectively, was broadcast and incorporated during seedbed preparation. The commercial hybrid 'Pioneer Brand 3147' was planted between May 1 and 10. The crop was planted at a higher than required seeding rate and subsequently thinned to a population of 14,000 plants per acre. Weeds were controlled by a preemergence application of alachlor [2-chloro-2',6'diethyl-*N*-(methoxymethyl)-acetanilide] and atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] at the respective rates of 0.9 and 0.7 lb/a. Chemicals were applied in a 14-inch band over the drill at planting. At the first cultivation, ammonium nitrate sufficient to bring the total N application of 180 lb/a was sidedressed and incorporated. During the second cultivation, 0.5 lb/a of 2,4-D (2,4-dichlorophenoxy acetic acid) was applied as a directed spray to control broadleaf weeds. Corn was harvested in late September and stalks shredded.

Grain sorghum

Preplant fertilizer containing 58, 58, and 58 lb/a of N, P_2O_5 and K_2O, respectively, was broadcast and incorporated during seedbed preparation. 'Funks BR-79' grain sorghum was seeded at 6 lb/a between May 10 and 15. Propazine [2-chloro-4,6-bis(isopropylamino)-*s*-

triazine] was applied at the rate of 1.2 lb/a at planting. Sufficient ammonium nitrate to bring the total N application to 100 lb/a was sidedressed and incorporated with the first cultivation. Escaped weeds were controlled using two or three cultivations. Grain yields were harvested in early September and plant residue was shredded.

Soybeans

Preplant fertilizer containing 80 and 80 lb/a of P_2O_5 and K_2O, respectively, was broadcast and incorporated during seedbed preparation. Trifluralin (α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine) at 1.0 lb/a was incorporated during the final disking of seedbed preparation. The cultivar 'Bragg' was planted at the rate of 45 pounds of seed per acre between May 15 and 20. Cultivation (two to three times each season) and linuron [3-(3,4 dichlorophenyl)-1-methoxy-1-methylurea] applied post-directed at 0.8 lb/a were used to control weeds. Soybeans were harvested in early November.

Sunflowers

Preplant fertilizer containing 58, 58, and 58 lb/a of N, P_2O_5, and K_2O, respectively, was broadcast and incorporated during land preparation. Trifluralin at 1.0 lb/a was incorporated during the final disking of seedbed preparation. Northrup King's oil-type, sunflower hybrid 'Sunbred Brand 212' was planted at the rate of 3.0 lb/a between May 1 and 10. After emergence the plant population was thinned to 14,000 plants per acre, and ammonium nitrate was drilled beside the row in sufficient amount to bring the total N application to 100 lb/a. The crop was cultivated one or two times, harvested in early September, and stalks were shredded.

Wheat

Preplant fertilizer containing 34, 55, and 55 lb/a of N, P_2O_5, and K_2O, respectively, was broadcast and incorporated during land preparation. In late February, wheat was topdressed with sufficient N from ammonium nitrate to bring the total application to 100 lb/a. The wheat was harvested in early June and the straw was left on the soil surface. These plots were fallowed during the summer by disking.

Doublecrops

In all treatments, annual rates of 70 and 67 lb/a of P_2O_5 and K_2O, respectively, were applied in the fall. These were considered maintenance rates sufficient to supply P and K for both wheat and the following summer crop (based on calculations from soil tests and uptake and removal by expected yields). In the doublecrop systems involving corn, grain sorghum, and sunflowers, phosphate and potash were incorporated during land preparation for wheat. For the system involving soybeans, where wheat was overseeded, phosphate and potash were broadcast on the surface immediately after harvesting soybeans. Wheat, except that cropped with soybeans, received 30 lb N/a in the preplant fertilizer. Wheat following soybeans did not receive any nitrogen at planting. Doublecrop and monocrop wheat were both topdressed in late February. Doublecropped wheat, except that following soybeans, received 70 lb/a of N from ammonium nitrate as a topdressing. Wheat following soybeans received 80 lb N/a in the spring.

Weed control consisted of 1.0 lb/a of alachlor for corn and soybeans, 1.2 lb/a of propazine for grain sorghum, and 1.5 lb/a of oryzalin (3,5-dinitro-N^4,N^4-dipropylsulfanilamide) for sunflowers as a broadcast spray at planting. Escaped weeds in soybeans were controlled with 0.7 lb/a of linuron as a post-directed spray. As with monocrops, doublecrop corn and sunflowers were planted at higher than required rates and later thinned to 14,000 plants per acre. Grain sorghum and soybeans were seeded at the same rate as the respective monocrops. Summer crops in doublecrop systems were cultivated twice each season. Diazinon [*O,O*-diethyl-*O* (2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate] at 1.2 lb/a was used to control midge (*Contarinia sorghicola* Coquillett) in doublecrop grain sorghum. Each of the row crops in the doublecrop systems was harvested 3 to 4 weeks after the corresponding monocrop.

Economic Analyses

Crop enterprise budgets were developed for each of the cropping alternatives. Budgets were based on the 3-year average yields obtained from the field study (Table 1). Rates of application for all the variable inputs were those described in the "Materials and Methods" section. Crop prices used in the budgets were 5-year average (1980-84) prices received by farmers in Mississippi. Costs of variable inputs and machinery were based on 1985 prices paid by farmers in the study area. In constructing the budgets, performance rates on all field operations were based on using six-row equipment with associated power units. This machinery complement was developed for a full-time operator labor component with the option of hiring additional labor each month on an hourly basis whenever operator labor was restrictive in carrying out farming operations. Available machine time for performing the crop production and harvesting operations was considered to be the most restrictive resource on the farm.

The power complement included one 90-100 drawbar horsepower (DBHP) tractor, one 115-150 DBHP tractor, and one 13-foot header width, self-propelled grain combine with auxiliary header and reel equipment

for harvesting corn and sunflowers. The equipment complement included a chisel plow, heavy disk, disk harrow, field cultivator, planter with no-till attachments, grain drill, cultivator, fertilizer applicator, stalk shredder, grain cart, spin spreader, and tractor-mounted sprayer.

Mathematical linear programming was used to select the combination of crops that would provide the highest net income. Constraints on resource availability in the programming analysis were hours suitable for field work during February through November for both tractor-powered tillage and nontillage operations and harvesting operations. Hours of operator labor available during February through November were also resource constraints, but with the option of hiring hourly labor each month at a wage rate of $4.45 per hour.

Results and Discussion

Agronomic Performance

Monocrops (excluding wheat)

Monocrop yields varied considerably over the 3-year period (Table 1). This reflects the erratic quantity and distribution of summer rainfall in this experiment and throughout the Midsouth. Monocrops produced their lowest yields in 1977, but their highest yields were produced in different years. Corn and soybeans produced their highest yields in 1978, while grain sorghum and sunflowers produced highest yields in 1979. Over the 3-year period, corn and grain sorghum yields were more variable than were soybean and sunflower yields. Corn yields ranged from 57.0 to 163.5 bu/a or a change of 287% from lowest to highest. Corresponding figures for grain sorghum, soybeans, and sunflowers were 44.2 bu/a to 88.6 bu/a or 200%, 27.5 bu/a to 35.8 bu/a or 130%, and 1,280 lb/a to 1,653 lb/a or 129%, respectively. These data demonstrate the hazards of producing corn, and to a lesser extent grain sorghum, in this area without irrigation. They further suggest that, of the alternatives tested, less year-to-year yield variability would be encountered with soybeans and sunflowers.

Doublecrops

Wheat yields, including monocrop wheat yields, were analyzed and the results are shown in Table 1. Monocrop wheat produced the highest 3-year mean yield. However, the monocrop wheat yield was not significantly higher than yield of wheat following commercial corn, soybeans, or sunflowers. The yield of doublecrop wheat was strongly influenced by the other crop in the system. Wheat following soybeans, sunflowers, and commercial corn produced significantly higher yields than wheat following grain sorghum. Yields following the two doublecrop corn entries were not significantly different. However, yields of wheat following commercial corn were consistently higher than those following resistant corn. This may have been partially due to the differences in amount of stover produced by the two corn hybrids.

Due to attacks by fall armyworms and rust, the commercial hybrid produced less stover than did the experimental hybrid. Incorporation of large amounts of carbonaceous residue has been shown to adversely affect a following wheat crop (8). Also, unused N applied to commercial corn may have affected the following wheat. Grain sorghum produces large amounts of residue, and wheat following grain sorghum produced the lowest yield each year. Incorporating grain sorghum residue has been shown to be especially detrimental to a following wheat doublecrop (8). No attempt was made to adjust the N rate for doublecrop wheat with respect to the amount of residue produced by the summer crop, except in the case of wheat following soybeans. Soybeans have been estimated to supply 27 to 36 lb N/a to a following wheat crop from the soybean residue (8). Note that wheat following soybeans produced among the top yields with only 80%

Table 1. Yields of five monocrop and five doublecrop production systems over a 3-year period on Leeper silty clay at Mississippi State University.

Cropping system and crop	Grain yield				
	1977	1978	1979	1980	Avg.
	bu/a[1]				
MONOCROPS:					
Corn (C)	57.0	163.5	121.6		114.0
Soybeans	27.5	35.8	32.8		32.0
Grain sorghum	44.2	87.1	88.6		73.2
Sunflowers	1,280	1,477	1,653		1,470
Wheat		(40.2)	(55.8)	(30.4)	(42.1)a[2]
DOUBLECROPS:					
Wheat -		(38.0)	(48.0)	(30.2)	(38.7)ab
corn (C)	-[3]	9.9	30.1		20.0[3]
Wheat -		(34.8)	(45.7)	(28.5)	(36.3)b
corn (R)	-[3]	66.7	59.4		63.0[3]
Wheat -		(39.1)	(50.5)	(31.7)	(40.4)a
soybeans	20.2	22.9	22.9		22.0
Wheat -		(31.8)	(39.6)	(25.3)	(32.2)c
grain sorghum	17.9	77.2	42.7		45.9
Wheat -		(37.4)	(51.0)	(33.5)	(40.6)a
sunflowers	1,322	1,549	1,328		1,400
Average		(36.9)b[2]	(48.4)a	(29.9)c	

[1] All yield units are bu/a except for sunflowers which are lb/a.

[2] Average yields within the column or row followed by the same letter are not significantly different at the 0.05 probability level using Duncan's Multiple Range Test.

[3] Commercial (C) and resistant (R) doublecrop corn were destroyed by a severe fall armyworm infestation in 1977. Average yields for doublecrop corn are averages of 1978 and 1979 yields.

as much fertilizer N as other wheat. However, wheat following soybeans was seeded about one month earlier than other wheat.

The summer crop portion of the doublecrops produced considerably less than did their monocrop counterparts, except for sunflowers. Doublecrop resistant corn produced 55% as much as did monocrop corn. Commercial doublecrop corn only produced 18% of the monocrop yield. Doublecrop soybeans produced 69% of the yield of monocrop soybeans. This agrees with results of another study at this location (5). The corresponding yield for doublecrop grain sorghum was 63%. Doublecrop sunflowers produced 95% of the monocrop sunflower yield.

Doublecrop corn (both commercial and resistant) failed in 1977 due to an overwhelming infestation of fall armyworm. Armyworms appeared earlier than normal in 1977 and numbers continued to increase during the summer. Although the resistant hybrid has a high degree of tolerance to fall armyworm, the 1977 results demonstrate that it cannot withstand extremely high numbers of worms. In 1978 and 1979, the resistant hybrid produced substantially more than did the commercial hybrid. Average yield for the commercial hybrid was only 32% of that of the resistant hybrid. We believe hybrids containing this resistance have potential as a late grain or silage crop. In a subsequent doublecropping study, a similar resistant hybrid produced 96 bu/a of grain with irrigation and 160 lb N/a (11).

Doublecrop grain sorghum suffered damage from fall armyworm in 1977 and to a lesser degree in 1978 and 1979. However, the worst pest of doublecrop grain sorghum was midge, which was especially severe and required two applications of insecticide each year. Monocrop sorghum, planted earlier, suffered only slight damage and was not treated for midge.

Although sunflowers performed well in this study, two important disadvantages of sunflower production in the Midsouth should be considered. Other studies at this location have shown sunflowers to be extremely susceptible to a leaf and stem disease (10) caused by the fungus (*Alternaria helianthi*) and to lodging from wind. Both conditions can usually be avoided by early planting. Additionally, bird damage can be a problem on late-planted sunflowers. Thus, doublecrop sunflowers are more at risk than are early planted monocrop sunflowers.

Generally, weed control was good in the study. However, tall morningglory (*Ipomoea purpurea*) and fall panicum (*Panicum dichotomiflorum*) appeared to increase in monocrop corn plots. We do not feel that this affected yields since these weeds only became noticeable after the corn had matured and light penetrated the canopy.

Yields of all doublecrop summer crops might have been higher if row spacing had been 30 inches or less. Since beginning this study, a positive crop yield response to narrow rows, when planting later than optimum, has been demonstrated in the South.

Economic Performance

Average net returns above variable expenses (Table 2) were lowest for the monocrops of grain sorghum, sunflowers and wheat and the doublecrops of wheat-commercial corn and wheat-grain sorghum. Highest net returns for monocrops were from commercial corn (C) and soybeans while wheat-resistant corn (R), wheat-soybeans, and wheat-sunflowers provided highest net returns for doublecrops.

Linear programming solutions were obtained for farming systems that included only monocrops, only doublecrops, and both monocrops and doublecrops. Diversifying land, machinery capital, and labor resources among monocrops and doublecrops resulted in higher net farm income than exclusive production of only monocrops or only doublecrops. The most profitable production systems for only monocrops and for both monocrops and doublecrops are summarized in Table 3. When only monocrops were considered, a farming system that includes 295.5 acres of commercial corn and 326.5 acres of wheat provides the highest net farm income of $12,651 when variable expenses, machinery ownership costs, and land costs are deducted from total cash receipts. This estimate of net farm income does not include any government payments to the farm operator under the target price/deficiency payment or commodity loan/diversion payment programs for corn and wheat.

A total farm size of 622 acres resulted from fully utilizing available tractor and operator labor time during April and October. Because commercial corn production entails high yield variability and risks without irrigation in this area, two additional computer programming solutions were obtained with commercial corn production limited to 100 acres and zero acres. Monocrop soybeans replaced commercial corn in the most profitable farming system.

The total farm size was increased to fully utilize the tractor and machinery complement during the restrictive months since monocrop soybeans require less tractor time than commercial corn during April and October. Replacing commercial corn with soybeans resulted in a substantial reduction in net returns to the operator's labor, management, and risk.

The wheat-resistant corn (221.7 acres) and wheat-soybean (208.5 acres) enterprises comprised the most profitable farming system when only doublecrops were considered (data not shown). Very restrictive limitations resulted for acres operated (430.2 acres) and net farm income attainable ($1,772) after variable expenses, machinery ownership costs, and land costs

Table 2. Annual expenses and net returns for alternative crops produced on Leeper silty clay at Mississippi State University[1].

Item	Monocrops					Doublecrops				
	Corn (C)	Soybeans	Grain sorghum	Sunflowers[2]	Wheat	Wheat-corn (C)	Wheat-corn (R)	Wheat-soybeans	Wheat-g. sorghum	Wheat-sunflowers[2]
INCOME:										
Yield (bu/a)	114.0	32.0	73.2	1,470	42.1	38.7	36.3	40.4	32.2	40.6
Price ($/bu)	3.17	6.78	2.41	.11	3.63	3.63	3.63	3.63	3.63	3.63
Yield (bu/a)						20.0	63.0	22.0	45.9	1,400
Price ($/bu)						3.17	3.17	6.78	2.41	.11
Total value ($/a)	361.38	216.96	176.41	161.70	152.82	203.88	331.48	295.81	227.51	301.38
VARIABLE EXPENSES ($/a):										
Fertilizer	81.75	38.30	58.97	58.97	57.15	113.84	113.84	65.35	92.01	92.01
Herbicides	7.23	15.03	5.26	6.23	.00	5.05	5.05	12.52	5.26	19.13
Insecticides	.00	.00	.00	.00	.00	.00	.00	.00	12.59	.00
Other	18.24	5.12	11.71	4.12	5.89	8.62	15.16	12.33	11.85	9.60
Seed	7.70	7.65	4.74	7.80	10.00	18.50	18.50	18.45	15.54	18 .60
Diesel Fuel	12.44	10.05	10.97	10.61	7.43	12.95	12.59	7.06	13.75	12.00
Repair and maint.	23.19	16.24	16.33	18.88	15.04	30.82	30.78	22.65	26.34	27.81
Interest on operating capital	6.46	4.62	4.99	6.00	6.43	8.58	8.31	5.73	8.58	8.37
Total variable exp.	157.01	97.01	112.97	112.61	102.74	198.36	204.23	142.09	185.92	187.52
Net return above variable expenses	204.37	119.95	63.44	49.09	50.08	5.52	127.25	153.72	41.59	113.86

[1] The crop enterprise costs and returns are based on the average yields shown in Table 1.
[2] Yield of sunflower seed is in lb/a and price of sunflower seed is $/lb.

Table 3. Most profitable production systems for general field crop farms using 6-row equipment on Leeper silty clay at Mississippi State University.

Item	Unit	Monocrops only			Monocrops and doublecrops		
		Without corn limitation[1]	With corn limitation[2]	No corn allowed[3]	Without corn limitation[1]	With corn limitation[2]	No corn allowed[3]
Crop enterprises:							
Corn (C)	acres	295.5	100.0	---	295.5	100.0	---
Soybeans	acres	---	260.6	394.0	---	260.6	393.9
Wheat	acres	326.5	326.5	326.5	33.2	---	---
Wheat & corn (R)	acres	---	---	---	153.0	170.4	170.4
Wheat & soybeans	acres	---	---	---	208.5	208.5	208.5
Total farm size	acres	622.0	687.1	720.5	690.2	739.5	772.8
Labor	hours	99.2	177.7	252.4	186.3	275.4	350.1
Net return above variable expenses	dollars	76,302	67,257	62,489	112,745	104,205	99,425
Machinery ownership expense	dollars	41,881	41,881	39,772	43,366	43,366	43,366
Land charge[4]	dollars	21,770	24,049	25,218	24,157	25,883	27,048
Net return above total specified expenses[5]	dollars	12,651	1,328	-2,500	45,222	34,956	29,011

[1] No limitation placed on the acres of monocrop corn allowed on the farm.
[2] Monocrop corn limited to a maximum of 100 acres.
[3] Monocrop corn was eliminated as a crop alternative on the farm.
[4] Land ownership and/or lease costs were charged at a rate of $35.00/acre.
[5] Net returns to general farm overhead and farm operator labor, management, and risk.

were paid. The requirements of tractor hours per acre were high during October and November since soybeans were being harvested and land was being fertilized and prepared for wheat. Decisions to devote all land to doublecrops would entail substantial reductions in net farm income.

Diversifying among monocrops and doublecrops in the farming system resulted in substantial gains in net farm income when compared with exclusive production of only monocrops or only doublecrops. Monocrop commercial corn (295.5 acres) dominated the most profitable solution and a small amount of monocrop wheat (33.2 acres) was included. Doublecrops of wheat-resistant corn (153.0 acres) and wheat-soybeans (208.5 acres) also were included in the most profitable farming system. Annual net farm income above variable expenses, machinery ownership costs, and land costs increased by $32,571 (to $45,222 annually) when compared to the most profitable farming system producing monocrops only (Table 3).

When limitations were placed on the amount of monocrop commercial corn allowed, monocrop wheat and corn were replaced with monocrop soybeans in the most profitable farming system. Annual net returns to operator labor, management, and risk were reduced by some $10,266 (with corn restricted to 100.0 acres) to $16,211 (with no corn allowed). The farm size that fully utilized the machinery complement in the restrictive months increased as monocrop soybeans replaced commercial corn in the farming system.

Diversifying among the doublecrop and monocrop alternatives allowed greater utilization of the machinery and operator labor complement. The results indicate that farm operators in Mississippi and the Midsouth with soil and other resources similar to those considered in this study could substantially increase their annual net farm income by doublecropping wheat with an experimental resistant corn and soybeans on about half of their cropland. Combining these doublecrops with the monocrops of commercial corn, wheat, or soybeans allows an expansion of the total land operated by about 7% to 10% through better utilization of machinery and equipment.

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Appendix Tables

Table 1. Monocrop corn, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Stalk Shredder	4-row	5	Oct	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton		Nov	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Mar	2.00	0.440	3.67	4.22	0.54	1.37	0.440				9.81
Spin Spreader	300 bu	3	Apr	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 13-13-13	cwt										4.460	8.86	39.52	39.52
Chisel Plow	16 ft	5	Apr	1.00	0.220	1.84	2.11	0.27	0.69	0.220				4.90
Disk Harrow	21 ft	5	Apr	2.00	0.280	2.34	2.68	1.26	2.59	0.280				8.87
Field Cult	21 ft	3	Apr	1.00	0.100	0.65	0.71	0.30	0.77	0.100				2.44
Plant + Pre.	6-row	5	Apr	1.00	0.180	1.50	1.73	0.66	1.69	0.180				5.58
Corn Seed	lb										7.000	1.10	7.70	7.70
Alachlor	lb										0.900	5.05	4.55	4.55
Atrazine	lb										0.700	2.19	1.53	1.53
Cultivate-Early	6-row	3	May	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cult Early + Fert	6-row	3	May	1.00	0.210	1.36	1.50	0.54	1.03	0.210				4.43
Nitrate (34% N)	cwt										3.660	9.49	34.73	34.73
Cult + Post-Late	6-row	5	Jun	1.00	0.180	1.50	1.73	0.33	0.74	0.180				4.30
2,4-D	lb										0.500	2.31	1.16	1.16
Combine-Corn	4-row		Sep	1.00	0.330			13.44	22.71	0.330				36.15
Grain Cart	250 bu	3	Sep	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Corn	bu		Sep	1.00							114.000	0.16	18.24	18.24
TOTALS						16.97	19.28	18.66	34.82				114.92	204.65
INTEREST ON OPERATING CAPITAL														6.46
TOTAL SPECIFIED COSTS														211.11

Table 2. Monocrop soybeans, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Lime (Spread) BB	ton		Nov	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Apr	3.00	0.660	5.51	6.33	0.81	2.06	0.660				14.71
Spin Spreader	300 bu	3	May	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-20-20	cwt										4.000	7.70	30.80	30.80
Disk + Incorp	21 ft	5	May	1.00	0.180	1.50	1.73	0.81	1.67	0.180				5.71
Trifluralin	lb										1.000	6.23	6.23	6.23
Field Cult	21 ft	3	May	1.00	0.100	0.65	0.71	0.30	0.77	0.100				2.44
Plant	6-row	5	May	1.00	0.140	1.17	1.34	0.44	1.13	0.140				4.08
Soybean Seed	lb										45.000	0.17	7.65	7.65
Cultivate-Early	6-row	3	Jun	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cult + Post-Late	6-row	5	Jun	1.00	0.180	1.50	1.73	0.33	0.74	0.180				4.30
Linuron	lb										0.800	10.67	8.54	8.54
Surfactant	pt										0.400	0.66	0.26	0.26
Cultivate-Late	6-row	3	Jul	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Combine-SB/WH	20 ft		Oct	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Oct	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Soybean	bu		Oct	1.00							32.000	0.16	5.12	5.12
TOTALS						14.01	15.90	12.28	22.82				66.10	131.12
INTEREST ON OPERATING CAPITAL														4.62
TOTAL SPECIFIED COSTS														135.74

Table 3. Monocrop grain sorghum, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						Dollars						Dollars		
Stalk Shredder	4-row	5	Oct	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton		Nov	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Mar	3.00	0.660	5.51	6.33	0.81	2.06	0.660				14.71
Spin Spreader	300 bu	3	Apr	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 13-13-13	cwt										4.460	8.86	39.52	39.52
Disk Harrow	21 ft	5	Apr	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Field Cult	21 ft	3	Apr	1.00	0.100	0.65	0.71	0.30	0.77	0.100				2.44
Plant + Pre.	6-row	5	Apr	1.00	0.180	1.50	1.73	0.66	1.69	0.180				5.58
Grain Sorghum														
Seed	lb										6.000	0.79	4.74	4.74
Propazine	lb										1.200	4.38	5.26	5.26
Cultivate-Early	6-row	3	May	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cult Early + Fert	6-row	5	Jun	1.00	0.210	1.75	2.01	0.54	1.03	0.210				5.34
Nitrate (34% N)	cwt										1.260	9.49	11.96	11.96
Cultivate-Late	6-row	3	Jul	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Combine-Grain														
SGM	20 ft		Sep	1.00	0.200			7.26	12.08	0.200				19.33
Grain Cart	250 bu	3	Sep	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Sorghum	bu		Sep	1.00							73.200	0.16	11.71	11.71
TOTALS						15.60	17.72	11.71	22.57				80.68	148.28
INTEREST ON OPERATING CAPITAL														4.99
TOTAL SPECIFIED COSTS														153.26

Table 4. Monocrop sunflower, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						Dollars						Dollars		
Stalk Shredder	4-row	5	Oct	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton		Nov	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Mar	3.00	0.660	5.51	6.33	0.81	2.06	0.660				14.71
Spin Spreader	300 bu	3	Mar	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 13-13-13	cwt										4.460	8.86	39.52	39.52
Disk + Incorp	21 ft	5	Mar	1.00	0.180	1.50	1.73	0.81	1.67	0.180				5.71
Trifluralin	lb										1.000	6.23	6.23	6.23
Field Cult	21 ft	3	Apr	1.00	0.100	0.65	0.71	0.30	0.77	0.100				2.44
Plant	6-row	5	Apr	1.00	0.140	1.17	1.34	0.44	1.13	0.140				4.08
Sunflower Seed	lb										3.000	2.60	7.80	7.80
Cult Early + Fert	6-row	5	Apr	1.00	0.210	1.75	2.01	0.54	1.03	0.210				5.34
Nitrate (34% N)	cwt										1.260	9.49	11.96	11.96
Cultivate-Late	6-row	3	May	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Combine-SF	4-row		Sep	1.00	0.300			11.13	18.57	0.300				29.70
Grain Cart	250 bu	3	Sep	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Sunflowers	cwt		Sep	1.00							14.700	0.28	4.12	4.12
TOTALS						14.24	16.22	15.26	28.25				77.12	151.08
INTEREST ON OPERATING CAPITAL														6.00
TOTAL SPECIFIED COSTS														157.08

Table 5. Monocrop wheat, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Lime (Spread) BB	ton		Aug	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Aug	2.00	0.440	3.67	4.22	0.54	1.37	0.440				9.81
Disk Harrow	21 ft	5	Sep	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Spin Spreader	300 bu	3	Oct	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-20-20	cwt										2.750	7.70	21.18	21.18
Nitrate (34% N)	cwt										1.000	9.49	9.49	9.49
Disk Harrow	21 ft	5	Oct	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Section Harrow	6-row	3	Oct	1.00	0.100	0.65	0.71	0.04	0.09	0.100				1.49
Grain Drill	24 ft	5	Oct	1.00	0.140	1.17	1.34	1.04	2.28	0.140				5.82
Wheat Seed	lb										90.000	0.12	10.80	10.80
Spin Spreader	300 bu	3	Feb	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Nitrate (34% N)	cwt										2.000	9.49	18.98	18.98
Combine-SB/WH	20 ft		Jun	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Jun	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Wheat	bu		Jun	1.00							42.100	0.14	5.89	5.89
TOTALS						9.89	11.24	12.57	22.85				73.84	130.39
INTEREST ON OPERATING CAPITAL														6.43
TOTAL SPECIFIED COSTS														136.82

Table 6. Wheat before commercial corn, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Stalk Shredder	4-row	5	Oct	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton		Oct	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Oct	2.00	0.440	3.67	4.22	0.54	1.37	0.440				9.81
Spin Spreader	300 bu	3	Oct	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-24-24	cwt										3.000	9.19	27.57	27.57
Nitrate (34% N)	cwt										0.900	9.49	8.54	8.54
Disk Harrow	21 ft	5	Oct	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Section Harrow	6-row	3	Oct	1.00	0.100	0.65	0.71	0.04	0.09	0.100				1.49
Grain Drill	24 ft	5	Oct	1.00	0.140	1.17	1.34	1.04	2.28	0.140				5.82
Wheat Seed	lb										90.000	0.12	10.80	10.80
Spin Spreader	300 bu.	3	Feb	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Nitrate (34% N)	cwt										2.100	9.49	19.93	19.93
Combine-SB/WH	20 ft		Jun	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Jun	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Wheat	bu		Jun	1.00							38.700	0.14	5.42	5.42
TOTALS						10.06	11.43	12.20	22.63				79.76	136.08
INTEREST ON OPERATING CAPITAL														6.65
TOTAL SPECIFIED COSTS														142.73

Table 7. Commercial corn after wheat, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						----------Dollars----------						----------Dollars----------		
Plant-NT+Pre	6-row	5	Jun	1.00	0.170	1.42	1.63	0.67	1.69	0.170				5.41
Corn Seed	lb										7.000	1.10	7.70	7.70
Alachlor	lb										1.000	5.05	5.05	5.05
Cultivate-Early	6-row	3	Jul	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cult Early + Fert	6-row	5	Jul	1.00	0.210	1.75	2.01	0.54	1.03	0.210				5.34
Nitrate (34% N)	cwt										5.300	9.49	50.30	50.30
Cultivate-Late	6-row	3	Aug	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Combine-Corn	4-row		Sep	1.00	0.330			13.44	22.71	0.330				36.15
Grain Cart	250 bu	3	Sep	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Corn	bu		Sep	1.00							20.000	0.16	3.20	3.20
TOTALS						6.21	7.00	15.30	26.88				66.25	121.64
INTEREST ON OPERATING CAPITAL														1.93
TOTAL SPECIFIED COSTS														123.57

Table 8. Wheat before resistant corn, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						----------Dollars----------						----------Dollars----------		
Stalk Shredder	4-row	5	Oct	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton		Oct	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Oct	2.00	0.440	3.67	4.22	0.54	1.37	0.440				9.81
Spin Spreader	300 bu	3	Oct	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-24-24	cwt										3.000	9.19	27.57	27.57
Nitrate (34% N)	cwt										0.900	9.49	8.54	8.54
Disk Harrow	21 ft	5	Oct	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Section Harrow	6-row	3	Oct	1.00	0.100	0.65	0.71	0.04	0.09	0.100				1.49
Grain Drill	24 ft	5	Oct	1.00	0.140	1.17	1.34	1.04	2.28	0.140				5.82
Wheat Seed	lb										90.000	0.12	10.80	10.80
Spin Spreader	300 bu	3	Feb	1.00	0.100	0.65	0.71	0.59	1.11	0.100	3.06			
Nitrate (34% N)	cwt										2.100	9.49	19.93	19.93
Combine-SB/WH	20 ft		Jun	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Jun	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Wheat	bu		Jun	1.00							36.300	0.14	5.08	5.08
TOTALS						10.06	11.43	12.20	22.63				79.42	135.74
INTEREST ON OPERATING CAPITAL														6.65
TOTAL SPECIFIED COSTS														142.39

Table 9. Resistant corn after wheat, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost Direct	Tractor Cost Fixed	Equip. Cost Direct	Equip. Cost Fixed	Labor Hours	Material (or service) Quant.	Material (or service) Price	Material (or service) Cost	Total Costs
						Dollars						Dollars		
Plant-NT + Pre	6-row	5	Jun	1.00	0.170	1.42	1.63	0.67	1.69	0.170				5.41
Corn Seed	lb										7.000	1.10	7.70	7.70
Alachlor	lb										1.000	5.05	5.05	5.05
Cultivate-Early	6-row	3	Jul	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cult Early + Fert	6-row	3	Jul	1.00	0.210	1.36	1.50	0.54	1.03	0.210				4.43
Nitrate (34% N)	cwt										5.300	9.49	50.30	50.30
Cultivate-Late	6-row	3	Aug	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Combine-Corn	4-row		Sep	1.00	0.330			13.44	22.71	0.330				36.15
Grain Cart	250 bu	3	Sep	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Corn	bu		Sep	1.00							63.000	0.16	10.08	10.08
TOTALS						5.81	6.48	15.30	26.88				73.13	127.61
INTEREST ON OPERATING CAPITAL														1.66
TOTAL SPECIFIED COSTS														129.27

Table 10. Wheat before soybeans, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost Direct	Tractor Cost Fixed	Equip. Cost Direct	Equip. Cost Fixed	Labor Hours	Material (or service) Quant.	Material (or service) Price	Material (or service) Cost	Total Costs
						Dollars						Dollars		
Lime (Spread) BB	ton		Nov	1.00							1.000	15.00	15.00	15.00
Spin Spreader	300 bu	3	Nov	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-24-24	cwt										3.000	9.19	27.57	27.57
Spin Spreader	300 bu	3	Feb	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Nitrate (34% N)	cwt										2.400	9.49	22.78	22.78
Combine-SB/WH	20 Ft		Jun	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Jun	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Wheat	bu		Jun	1.00							40.400	0.14	5.66	5.66
TOTALS						2.07	2.28	9.70	16.51				71.00	101.56
INTEREST ON OPERATING CAPITAL														4.36
TOTAL SPECIFIED COSTS														105.92

Table 11. Soybeans after wheat, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Plant-NT + Pre	6-row	5	Jun	1.00	0.170	1.42	1.63	0.67	1.69	0.170				5.41
Soybean Seed	lb										45.000	0.17	7.65	7.65
Alachlor	lb										1.000	5.05	5.05	5.05
Cultivate-Early	6-row	3	Jul	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cultivate-Late	6-row	3	Jul	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Cult + Post-Late	6-row	5	Aug	1.00	0.180	1.50	1.73	0.33	0.74	0.180				4.30
Linuron	lb										0.700	10.67	7.47	7.47
Plant by Air			Oct	1.00										0.00
Plant by Air	cwt										0.900	3.50	3.15	3.15
Wheat Seed	lb										90.000	0.12	10.80	10.80
Combine-SB/WH	20 ft		Nov	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Nov	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Soybean	bu		Nov	1.00							22.000	0.16	3.52	3.52
TOTALS						5.96	6.71	9.99	17.77				37.64	78.07
INTEREST ON OPERATING CAPITAL														1.37
TOTAL SPECIFIED COSTS														79.44

Table 12. Wheat before grain sorghum, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Stalk Shredder	4-row	5	Oct	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton		Oct	1.00							0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Oct	2.00	0.440	3.67	4.22	0.54	1.37	0.440				9.81
Spin Spreader	300 bu	3	Oct	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-24-24	cwt										3.000	9.19	27.57	27.57
Nitrate (34% N)	cwt										0.900	9.49	8.54	8.54
Disk Harrow	21 ft	5	Oct	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Section Harrow	6-row	3	Oct	1.00	0.100	0.65	0.71	0.04	0.09	0.100				1.49
Grain Drill	24 ft	5	Oct	1.00	0.140	1.17	1.34	1.04	2.28	0.140				5.82
Wheat Seed	lb										90.000	0.12	10.80	10.80
Spin Spreader	300 bu	3	Feb	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Nitrate (34% N)	cwt										2.100	9.49	19.93	19.93
Combine-SB/WH	20 ft		Jun	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Jun	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Wheat	bu		Jun	1.00							32.200	0.14	4.51	4.51
TOTALS						10.06	11.43	12.20	22.63				78.85	135.17
INTEREST ON OPERATING CAPITAL														6.65
TOTAL SPECIFIED COSTS														141.82

Table 13. Grain sorghum after wheat, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Plant-NT+Pre Grain Sorghum	6-row	5	Jun	1.00	0.170	1.42	1.63	0.67	1.69	0.170				5.41
Seed	lb										6.000	0.79	4.74	4.74
Propazine	lb										1.200	4.38	5.26	5.26
Cultivate-Early	6-row	3	Jul	1.00	0.210	1.36	1.50	0.28	0.63	0.210				3.77
Cult Early + Fert	6-row	5	Jul	1.00	0.210	1.75	2.01	0.54	1.03	0.210				5.34
Nitrate (34% N)	cwt										3.000	9.49	28.47	28.47
Cultivate-Late Spray-TR	6-row	3	Aug	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Mount-3Pt.	21 ft	3	Aug	2.00	0.360	2.33	2.57	0.18	0.34	0.360				5.41
Diazinon	lb										1.200	10.49	12.59	12.59
Combine-Grain SGM	20 ft		Oct	1.00	0.200			7.26	12.08	0.200				19.33
Grain Cart	250 bu	3	Oct	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Sorghum	bu		Oct	1.00							45.900	0.16	7.34	7.34
TOTALS						8.53	9.57	9.30	16.59				58.40	102.38
INTEREST ON OPERATING CAPITAL														1.93
TOTAL SPECIFIED COSTS														104.31

Table 14. Wheat before sunflower, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						---Dollars---						---Dollars---		
Stalk Shredder	4-row	5	Sep	1.00	0.160	1.34	1.53	0.26	1.08	0.160				4.21
Lime (Spread) BB	ton	Sep	1.00								0.500	15.00	7.50	7.50
Chisel Plow	16 ft	5	Oct	2.00	0.440	3.67	4.22	0.54	1.37	0.440				9.81
Spin Spreader	300 bu	3	Oct	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Fert 0-24-24	cwt										3.000	9.19	27.57	27.57
Nitrate (34% N)	cwt										0.900	9.49	8.54	8.54
Disk Harrow	21 ft	5	Oct	1.00	0.140	1.17	1.34	0.63	1.30	0.140				4.44
Section Harrow	6-row	3	Oct	1.00	0.100	0.65	0.71	0.04	0.09	0.100				1.49
Grain Drill	24 ft	5	Oct	1.00	0.140	1.17	1.34	1.04	2.28	0.140				5.82
Wheat Seed	lb										90.000	0.12	10.80	10.80
Spin Spreader	300 bu	3	Feb	1.00	0.100	0.65	0.71	0.59	1.11	0.100				3.06
Nitrate (34% N)	cwt										2.100	9.49	19.93	19.93
Combine-SB/WH	20 ft		Jun	1.00	0.230			8.35	13.89	0.230				22.24
Grain Cart	250 bu	3	Jun	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Wheat	bu		Jun	1.00							40.600	0.14	5.68	5.68
TOTALS						10.06	11.43	12.20	22.63				80.02	136.34
INTEREST ON OPERATING CAPITAL														6.75
TOTAL SPECIFIED COSTS														143.09

Table 15. Sunflower after wheat, 6-row equipment. Estimated operation costs per acre, Blackbelt Area, Mississippi, 1985.

Operation or Item	Size or Unit	Trac. Num.	Month Perf.	Times Over	Mach. Hours	Tractor Cost		Equip. Cost		Labor	Material (or service)			Total Costs
						Direct	Fixed	Direct	Fixed	Hours	Quant.	Price	Cost	
						Dollars							Dollars	
Plant-NT + Pre	6-row	5	Jun	1.00	0.170	1.42	1.63	0.67	1.69	0.170				5.41
Sunflower Seed	lb										3.000	2.60	7.80	7.80
Oryzalin	lb										1.500	12.75	19.13	19.13
Cult Early + Fert	6-row	5	Jul	1.00	0.210	1.75	2.01	0.54	1.03	0.210				5.34
Nitrate (34% N)	cwt										3.000	9.49	28.47	28.47
Cultivate-Late	6-row	3	Aug	1.00	0.140	0.90	1.00	0.19	0.42	0.140				2.51
Combine-SF	4-row		Sep	1.00	0.300			11.13	18.57	0.300				29.70
Grain Cart	250 bu	3	Sep	1.00	0.120	0.78	0.86	0.18	0.40	0.120				2.21
Haul Sunflowers	cwt		Sep	1.00							14.000	0.28	3.92	3.92
TOTALS						4.85	5.50	12.70	22.11				59.31	104.48
INTEREST ON OPERATING CAPITAL														1.62
TOTAL SPECIFIED COSTS														106.11

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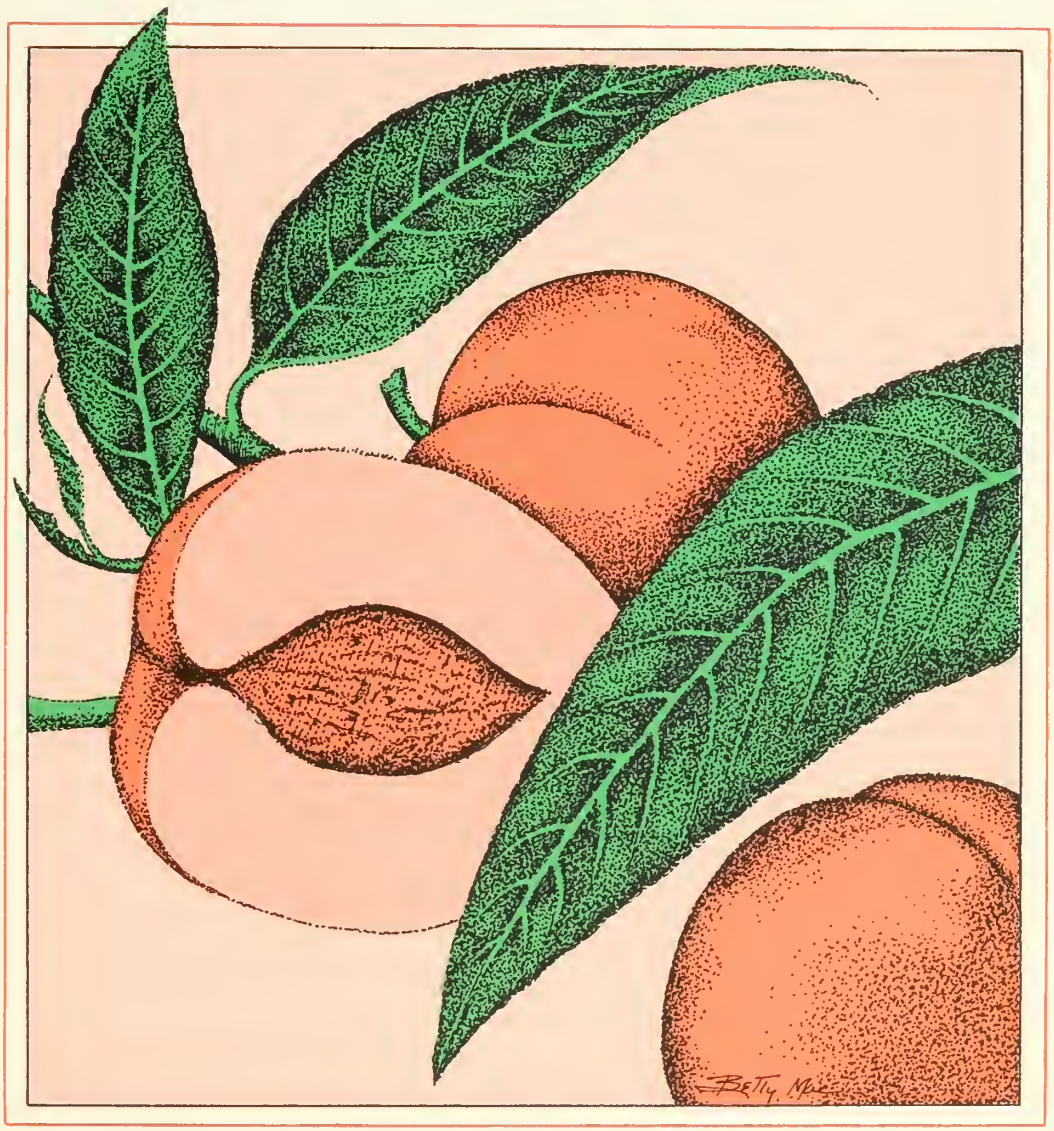

Evaluation of Peach Cultivars for North Mississippi, 1973-1986

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Evaluation of Peach Cultivars for Northern Mississippi, 1973-1986

Peach cultivar evaluations by the Mississippi Agricultural and Forestry Experiment Station were initiated in 1898 (7), with results reported in 1905 (7), 1911 (6), 1930 (11), 1947 (5), 1959 (10), and 1966 (9). Recommended practices for growing peaches in Mississippi have been published by the Mississippi Cooperative Extension Service (8).

Many of the old peach cultivars recommended for Mississippi have been lost through discontinued propagation or have succumbed to pests and diseases. In recent years, new, more desirable cultivars have been developed and renewed interest in peach production in Mississippi has prompted potential growers to seek information on adapted cultivars. Inquiries concerning performance and adaptability of new peach cultivars prompted the continuation of peach cultivar evaluations. This bulletin presents results of peach cultivars evaluated from 1973 through 1986.

Materials and Methods

A total of 108 peach cultivars were evaluated from 1973 through 1986 at the MAFES Pontotoc Ridge-Flatwoods Branch Experiment Station. Trees were spaced 20 by 22 feet in randomized complete block design with four replications and a single tree per replicate. Fifty-six (56) cultivars were planted in 1973, 23 were planted in 1976, and 27 cultivars were planted in 1979. Trees were trained to the open center system and pruned annually. The sod strip method of culture was maintained using herbicides under tree rows (14-foot band) and a mowed grass strip between rows. Nitrogen was applied when new shoot growth was less than 12 inches each year. Split applications were used; one in mid-February and one in early May. Current recommended spray schedules provided by the Mississippi Cooperative Extension Service were followed for the control of insects and diseases.

Fruits were thinned to maintain a fruit approximately every six inches on a fruiting limb. Fruit thinning was done soon after blossoming and completed shortly after the "June drop."

Fruit of each cultivar were harvested as indicated by changes in ground color. Therefore, fruit from a given tree was harvested more than once, and only when the fruit was fully matured. The fruit was not allowed to become over ripe to avoid picking of soft fruit.

Yields of cultivars planted in a given year were analyzed by analysis of variance and yield means separated by the L.S.D. procedure.

Fruit characteristics were based on sub-sample of 20 peaches per cultivar. Texture and flavor were measured by a taste panel using a 9-point hedonic scale for organoleptic evaluation. On this scale, 9 means "like extremely" and 1 means "dislike extremely." Soluble solids were measured with an Abbe refractometer at 20°C.

Attractiveness scores were based on overall appearance of the fruit. On this scale 8 was "excellent" and 5 was "poor." Skin red color of fruit was determined by visual observation and expressed as percentage of red on entire fruit.

Results

Table 1 presents total and annual yields in pounds per tree of peach cultivars planted in 1973 and evaluated through 1982. First significant production for all cultivars occurred in 1977, 4 years after transplanting. There was a significant difference in total yield between cultivars in the years tested. Yields by cultivar varied depending on year. There was a significant difference in annual yields between cultivars.

Yields in 1977 were generally lower than other years because the trees were growing rapidly and just coming into production. Low yields reported in 1979 resulted from a late spring frost that reduced the crop severely. In general, maximum production for all cultivars occurred in 1981, the fifth year of production.

On a 6-year production average, cultivars Harbelle, Harbrite, Loring, Princess Anne, Redhaven, Sunqueen, and Troy significantly out-yielded all cultivars except Bisco, Candor, Earlired, Harbinger, Harken, Legacy, Pacific Gold, Pratt's Redhaven, Redskin, Reliance, Rosy Dawn, Rubired, Sam Houston, Sentinel, Summergold, Suncrest, Sunshine, Winblo, and Zachary Taylor.

Pekin and Norman significantly out-yielded Candor, Compact Redhaven, Sam Houston, Sentinel, Summergold, Suncrest, Zachary Taylor, and all remaining cultivars except Harbelle, Harbrite, Loring,

Table 1. Annual, total, and average yields of peach tree cultivars grown at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1973-1982.

Cultivar	Year						Total	Average
	1977	1978	1979	1980	1981	1982		
	pounds per tree*							
Bisco	121	154	135	114	111	140	775	129
Camdon	105	158	31	74	156	-	524	105
Candor	102	271	80	88	82	125	748	125
Comanche	41	113	28	148	117	123	570	95
Compact Redhaven	80	127	36	70	189	141	643	107
Dixired	111	115	37	86	272	31	652	109
Earlired	113	217	72	77	181	124	784	131
Emery	126	122	33	82	146	119	628	105
Harbelle	180	245	50	125	232	74	906	151
Harbinger	60	155	36	74	201	162	688	115
Harbrite	106	225	56	84	173	216	860	143
Harken	144	246	53	84	186	108	821	137
Harmony	126	182	21	52	253	34	668	111
Harvester	54	82	4	4	151	120	415	69
Jefferson	109	88	32	76	264	53	622	104
Jim Bowie	44	103	-	20	71	5	243	49
La Gold	120	229	7	45	165	81	647	108
Legacy	134	220	49	157	147	86	793	132
Loring	124	202	28	80	337	114	885	148
Marglow	35	106	27	13	103	171	482	80
Marqueen	63	86	10	-	7	77	243	49
Marhigh	83	104	18	20	70	114	409	68
Marland	53	68	12	84	70	149	436	73
Marpride	77	92	15	86	146	110	526	88
Marsun	80	116	-	62	83	4	345	69
Maycrest	40	72	62	123	170	90	557	93
McNeely	126	144	5	42	274	60	651	109
Norman	154	252	59	162	139	168	934	156
Pacific Gold	130	193	86	151	176	98	834	139
Pekin	169	244	99	160	199	159	1,030	172
Pratt's Redhaven	61	173	12	74	182	273	775	129
Princess Anne	177	237	13	147	192	79	845	141
Redhaven	138	200	96	118	186	173	911	152
Redskin	104	144	74	180	142	175	819	137
Reliance	128	162	45	71	194	178	778	130
Rio Oso Gem	62	120	14	40	127	174	537	90
Rosy Dawn	134	251	8	81	279	64	817	136
Rubired	184	190	31	170	195	48	818	136
Sam Houston	72	102	31	79	179	270	733	122
Sentinel	62	128	37	124	189	201	741	124
Somerset	116	152	59	76	199	57	659	110
Springbrite	29	54	20	77	114	114	408	68
Springcrest	44	67	17	92	111	96	427	71
Springold	57	65	13	81	121	48	385	64
Summergold	58	132	48	99	173	171	681	114
Suncrest	54	113	10	172	135	200	684	114
Sunqueen	143	170	25	66	323	118	845	141
Sunshine	88	196	23	89	220	184	800	133
Surecrop	53	117	31	63	188	160	612	102
Troy	161	257	39	57	212	127	853	142
Tyler	117	144	25	17	208	48	559	93
Velvet	76	123	15	84	161	168	627	105
Washington	120	79	18	16	234	68	535	89
Whynot	49	10	5	73	87	-	224	45
Winblo	152	199	45	99	257	33	785	131
Zachary Taylor	58	124	49	-	157	176	564	113
LSD (0.05)	40.5	73.0	38.0	80.2	79.5	84.0	181.4	30.2

*Dash (-) indicates that data are not available.

Princess Anne, Redhaven, Sunqueen, and Troy.

Low producers were Whynot, Jim Bowie, Marqueen, Springold, Marsun, Marland, Marhigh, Marglow, Harvester, Springbrite, and Springcrest. Yields per tree ranged from an average high for Pekin of 172 to a low for Whynot of 45.

Table 2 summarizes yields of cultivars planted in 1975. Yields in 1978 and 1980 were low since the trees were still growing and coming into production. In 1979, a late spring frost reduced the crop severely and low yields were reported. In general, maximum production for all cultivars occurred in 1982, the fifth year of production.

Autumn Gold, Elberta, Yakima Hale, and La Gem produced significantly higher yields than La Red, Sunside, Red Top, Summertime, Fairway, Fairtime, and Hamlet. Elberta also out-yielded Inman Tinsley, Magnolia, Sunbrite, and Ranger. La Premier, Monroe, Yakima Hale, Clayton, NJ 97, Beekman, and Ellerbe had comparable yields. Yields ranged from an average high for Elberta of 99 pounds per tree to a low for Fairtime of 35 pounds per tree.

Table 3 summarizes yields of cultivars planted in 1979. Yields in 1981 were generally low since the trees were growing and coming into production. In 1983, the temperature dropped to 25°F during bloom, reducing yields about 63 percent below those of 1982. Cultivars were affected differently, depending on the stage of flowering at the time of the freeze. In 1984, the trees were approaching maximum yield potential. In 1985, a complete crop loss was recorded due to a winter freeze January 19 which destroyed all flower buds. In 1986, a 90 percent crop loss was reported due to a late spring frost when temperature dipped to 21°F on March 20. Cultivars which produced a 50 percent crop or more in 1986 were

Stark Frost King, Royalvee, NJ 97, and Redkist.

Stark Sunbright and Vivid significantly out-produced all cultivars except Blake, Brighton, Cullinan, Harrison, and Spartan. Cultivars with extremely low total yields were Flamecrest, Golden Monarch, and Stark Frost King. Four-year average yields ranged from a high of 154 pounds per tree for Vivid to a low of 27 pounds per tree for Flamecrest. Average peach tree yields (4 production years) reported in Alabama ranged from a high of 192 to a low of 42 pounds per tree. The average yield for all cultivars in the Alabama trials was 98 pounds per tree (4). Mississippi yields reported in this bulletin are similar to those reported in Alabama. The average yield for all cultivars planted in 1973 was 111 pounds. The average yield per tree for all cultivars planted in 1975 was 67 pounds, and those planted in 1979 averaged 81 pounds per tree. When making yield comparisons, it should be remembered that yields are dependent on cultivar, the climate in a given year, and geographical location and cultural practices.

Table 4 presents cultivars by average first harvest date. The ripening season is important for selecting cultivars with a ripening sequence to provide ripe fruit continuously from late May to mid or late August. First harvest dates may vary from year to year because of prolonged dormancy, very early spring bloom, very cold weather in early spring, and/or other weather variables. Heavy spring nitrogen applications can also delay harvest dates.

Fruit characteristics are also listed in Table 4. Flesh color is of primary importance when peaches are grown for fresh market. Yellow-fleshed peaches are usually preferred. However, local markets may demand white-fleshed peaches with unusual qualities, such as the

Table 2. Annual, total, and average yields of peach cultivars planted in 1975 at the Pontotoc Ridge-Flatwoods Branch Experiment Station.

Cultivar	Year							Total	Average
	1978	1979	1980	1981	1982	1983	1984		
	pounds per tree*								
Autumn Gold	19	12	6	125	230	104	200	722	90
Beekman	3	12	60	102	195	44	86	502	72
Clayton	16	3	83	96	176	56	86	516	74
Correll	4	6	15	53	102	38	79	297	42
Elberta	37	18	55	116	309	88	147	789	99
Ellerbe	5	7	67	147	195	54	120	595	85
Fairtime	0	0	10	72	8	25	62	177	35
Fairway	0	4	13	67	36	37	146	303	51
Hamlet	0	0	1	32	84	35	60	212	42
Inman Tinsley	32	2	112	66	104	81	101	510	64
La Gem	0	4	23	87	187	17	219	537	90
La Premier	69	6	89	129	221	58	62	652	82
La Red	7	2	17	93	192	49	24	384	55
Magnolia	9	4	-	117	132	119	93	478	68
Monroe	28	12	12	142	114	74	189	583	73
NJ 97	16	0	10	106	221	48	73	474	79
Ranger	5	0	19	80	187	15	94	400	67
Red Top	8	2	15	104	160	28	65	382	55
Summertime	5	0	9	22	162	17	51	266	44
Sunbrite	18	3	22	112	213	89	52	513	64
Sunside	9	0	11	53	180	15	53	321	54
Yakima Hale	24	6	17	170	144	87	159	607	87
LSD (0.05)	15.5	4.8	29.2	50.9	67.5	44.4	72.7	250.5	31.3

*Dash (-) indicates data are not available.

Table 3. Annual, total, and average yield of peach tree cultivars planted in 1979 at the Pontotoc Ridge-Flatwoods Branch Experiment Station.

Cultivar	Year				Total	Average
	1981	1982	1983	1984		
	pounds per tree*					
Blake	28	96	78	156	358	90
Brighton	24	113	54	244	435	109
Cary Mac	42	49	74	103	268	67
Cullinan	20	107	108	318	553	138
Fayette	49	124	15	69	257	64
Flamecrest	4	26	76	-	106	27
Georgia Belle	20	93	23	135	271	68
Golden Monarch	18	75	45	47	185	46
Harrison	31	120	114	240	505	126
Havis	16	102	24	151	293	73
Jersey Queen	43	98	18	77	236	59
Kimbo	20	31	38	146	235	59
Milam	31	70	32	177	310	78
Redkist	22	68	51	116	257	64
Royalvee	18	75	68	111	272	68
Spartan	31	126	102	142	401	100
Stark Earliglo	10	59	69	52	190	48
Stark Earli Loring	20	112	31	117	280	70
Stark Frost King	16	60	32	53	161	40
Stark Sunbright	20	204	132	236	592	148
Vivid	70	288	100	158	616	154
LSD (0.05)	16.3	42.3	25.2	42.0	276.8	69.2

*Dash (-) indicates data are not available.

Table 4. Average first harvest date and marketable fruit characteristics of peach cultivars grown at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1973-1986.

Cultivar	Av. date first harvest	No. years fruited	Skin red (%)	Attractiveness[1]	Stone freeness[2]	Texture[3]	Flesh color[4]	Flavor[3]	Soluble solids (%)
Whynot	5/26	6	-	-	C	-	Y	-	-
Springcrest	5/30	6	95	8	C	7	Y	6	10.0
Harbinger	5/31	6	60	7	C	7	Y	5	11.2
Hamlet	6/4	7	-	-	C	-	Y	-	-
Springbrite	6/4	6	94	8	F	6	Y	6	10.0
Springold	6/4	6	95	8	C	7	Y	6	10.0
Candor	6/6	6	85	7	SC	9	Y	8	11.6
Earlired	6/6	6	88	8	C	7	Y	7	11.3
Correll	6/9	7	85	6	C	7	Y	6	12.1
Inman Tinsley	6/10	7	80	7	F	7	Y	8	12.7
Magnolia	6/10	7	90	5	C	5	Y	5	14.0
Dixired	6/13	6	95	8	C	8	Y	8	12.2
Harbelle	6/13	6	60	7	SF	7	Y	7	12.0
Legacy	6/13	6	82	7	C	7	Y	8	11.6
Maycrest	6/14	6	93	8	C	7	Y	8	10.6
Pacific Gold	6/14	6	88	-	C	-	Y	8	10.9
Rubired	6/14	6	82	7	C	7	Y	7	12.9
Surecrop	6/15	6	50	6	C	7	Y	8	13.0
Comanche	6/17	6	65	6	SF	6	Y	7	12.5
Stark Earliglo	6/19	4	-	-	F	-	Y	-	-
Harken	6/20	6	88	8	F	7	Y	8	-
Royalvee	6/20	4	-	-	SC	-	Y	-	-
Golden Monarch	6/21	4	-	-	F	-	Y	-	-
Sam Houston	6/21	6	77	7	SC	7	Y	8	14.9
Clayton	6/25	7	-	-	F	-	Y	-	-
Sentinel	6/25	6	84	8	SF	7	Y	8	12.9
Sunside	6/25	7	90	7	F	8	Y	8	15.3
Brighton	6/26	4	-	-	F	-	Y	-	-
Pekin	6/27	6	95	8	SF	8	Y	7	11.8
Harbrite	6/29	6	88	8	F	8	Y	7	11.2
Sunshine	6/29	6	88	8	F	8	Y	8	11.7
NJ 97	6/3	0	50	6	C	8	Y	8	16.8
Ranger	7/1	7	-	-	F	-	Y	-	-
Redhaven	7/2	6	93	8	F	7	Y	8	13.2
Reliance	7/2	6	65	7	F	7	Y	7	13.5
Norman	7/3	6	95	7	SF	8	Y	8	13.2
Princess Anne	7/3	6	95	8	F	8	Y	8	13.9
Compact Redhaven	7/5	6	70	7	F	7	Y	7	11.4
Stark Earli Loring	7/4	4	-	-	F	-	Y	-	-
Velvet	7/4	6	-	-	F	-	Y	-	-
Pratt's Redhaven	7/5	6	20	6	F	8	Y	7	11.0
Red Top	7/5	7	88	7	F	8	Y	8	14.2
Loring	7/6	6	60	8	F	7	Y	7	12.0
Troy	7/6	6	90	8	F	8	Y	8	11.5
Vivid	7/6	4	-	-	F	-	Y	-	-
Harvester	7/7	6	-	-	F	-	Y	-	-
Spartan	7/7	4	-	-	C	-	Y	-	-
Sunbrite	7/8	7	94	8	F	6	Y	6	10.0
Washington	7/8	6	90	8	F	7	Y	7	13.0
Cary Mac	7/9	4	-	-	F	-	Y	-	-
Cullinan	7/9	4	-	-	F	-	Y	-	-
Harrison	7/9	4	-	-	F	-	Y	-	-
La Premier	7/9	7	90	8	F	8	Y	8	13.4
Stark Sunbright	7/9	4	-	-	F	-	Y	-	-
Winblo	7/9	6	83	8	F	7	Y	8	12.3
Flamecrest	7/10	4	-	-	F	-	Y	-	-
McNeely	7/10	6	-	-	F	-	Y	-	-
Summertime	7/10	7	-	-	F	-	Y	-	-
Beekman	7/11	7	-	-	F	-	Y	-	-

Continued

Table 4 (cont.). Average first harvest date and marketable fruit characteristics of peach cultivars grown at the Pontotoc Ridge-Flatwoods Branch Experiment Station, 1973-1986.

Cultivar	Av. date first harvest	No. years fruited	Skin red (%)	Attractiveness[1]	Stone freeness[2]	Texture[3]	Flesh color[4]	Flavor[3]	Soluble solids (%)
Rosy Dawn	7/11	6	65	7	F	6	Y	7	12.8
Ellerbe	7/12	7	60	7	F	8	Y	8	14.7
Harmony	7/12	6	85	-	F	7	Y	8	12.5
Suncrest	7/12	6	95	-	F	8	Y	8	13.8
Fairway	7/13	7	60	6	F	8	Y	7	15.0
La Red	7/15	7	90	7	F	7	Y	8	13.4
Redkist	7/15	4	-	-	F	-	Y	-	-
Summergold	7/15	6	88	8	F	8	Y	8	13.8
Sunqueen	7/15	6	50	7	F	8	Y	7	12.4
Zachary Taylor	7/15	6	90	8	F	8	Y	8	14.8
La Gold	7/16	6	30	7	F	7	Y	7	13.0
Stark Frost King	7/17	4	-	-	F	-	Y	-	-
Milam	7/18	4	-	-	F	-	Y	-	-
Belle of Georgia	7/27	4	-	8	F	6	W	8	12.2
Biscoe	7/27	6	70	7	F	8	Y	8	-
Marqueen	7/27	6	60	7	F	8	Y	8	16.4
Redskin	7/28	6	85	8	F	7	Y	8	14.7
Jefferson	7/29	6	40	7	F	7	Y	8	-
Somerset	7/31	6	95	8	F	8	Y	8	13.7
Autumn Gold	8/3	7	30	7	F	7	Y	7	15.0
Blake	8/3	4	-	-	F	-	Y	-	-
Elberta	8/3	7	-	7	F	8	Y	8	15.9
Havis	8/5	4	-	-	F	-	Y	-	-
Yakima Hale	8/6	7	80	8	F	8	Y	8	16.1
Marhigh	8/7	6	95	8	F	8	Y	8	14.4
Kimbo	8/8	4	-	-	F	-	Y	-	-
Marland	8/9	6	95	8	F	8	Y	8	15.2
Marglow	8/10	6	90	8	F	7	Y	8	14.9
Marpride	8/10	6	90	8	F	8	Y	8	15.4
Tyler	8/10	6	55	8	F	8	Y	7	13.1
Fayette	8/12	4	85	6	F	7	Y	7	15.2
Monroe	8/12	7	90	8	F	8	Y	8	15.4
Rio Oso Gem	8/12	6	77	7	F	8	Y	8	13.2
Emery	8/13	6	45	7	F	8	Y	7	15.4
La Gem	8/13	7	85	7	SF	8	Y	8	16.2
Jersey Queen	8/14	4	-	-	F	-	Y	-	-
Jim Bowie	8/19	6	-	-	F	8	Y	7	-
Fairtime	8/29	7	-	-	F	-	Y	-	-
Marsun	9/4	6	30	7	F	8	Y	8	16.0

[1] Rating; 8 = excellent, 5 = poor.

[2] C = cling, F = freestone, SF = semi-freestone.

[3] Taste panel score; 9 = like extremely, 1 = dislike extremely.

[4] Y = yellow, W = white.

excellent texture and flavor of Georgia Belle. The processing quality of peach cultivars is influenced by many factors, such as fruit size, season, uniformity of maturity, taste, color intensity and uniformity, ease of pitting, and freedom from discoloration. Ease of pitting, freedom from split-pits, and freedom from discoloration are perhaps the three most important factors affecting suitability for processing. Many early season cultivars having excellent dessert qualities cannot be successfully pitted with equipment currently in use. In contrast, the late-season cultivars tend to discolor after canning. Cultivars such as Blake and Rio Oso Gem may contain too much red pigment in the flesh for satisfactory canning but provide a very attractive frozen product (3).

In general, early-ripening peach cultivars are clingstone or semifree, and late-ripening cultivars are freestone. Consumer acceptance studies of Mississippi canned peaches have previously been reported (1, 2). Consumers generally considered Mississippi and California peaches more similar in flavor than in appearance. In this study, flavor and texture ratings (on a scale of 1-9) were 6 or above for all cultivars, indicating good quality as measured by taste panels.

Peach attractiveness and fruit size are primary factors that contribute to the sale of fresh market peaches. Attractiveness is influenced by the amount (percent) of skin that's colored red, color intensity, and shape of fruit. Percent skin colored red ranged from a high of 95 for Springcrest, Springold, Dixired, Pekin, Norman, and Princess Anne, to a low of 20 percent for Pratt's Redhaven. Most peaches in this study received an attractiveness rating of 6 or above with the exception of 'Magnolia' which scored only 5. Percent soluble solids ranged from a low of 10 for Springcrest, Springbrite, Springold, and Sunbrite, to a high of 16.8 for NJ 97 and 16.4 for Marqueen. In general, the early ripening peaches have less sugar (low % soluble solids) than late-ripening cultivars. Therefore, peaches with high soluble solids are not necessarily sweet. A cultivar with medium sugar and low acid might taste sweeter than a high sugar-high acid cultivar. As noted in Table 4, cultivars that have excellent flavor do not always have high soluble solids.

Based on over-all cultivar performance, which includes yield and various fruit characteristics, Table 5 lists various cultivar recommendations for northern Mississippi growers.

Other cultivars that should be considered for commercial production are La Premier, Yakima Hale, Monroe, Clayton, NJ 97, Beekman, Ellerbe, Blake, Brighton, Cullinan, Harrison, Spartan, Harken, Legacy, Earlired, Redskin, Winblo, Reliance, Biscoe, Candor, Pratt's Redhaven, Sentinel, and Sam Houston. Cultivars such as Stark Frost King, Redkist, Royalvee, and NJ 97, that produced a significant crop after a late spring frost in 1986 may also be highly desirable.

For additional information on these and other peach cultivars and their uses, write the Department of Horticulture, Mississippi State University, Mississippi State, MS 39762. Peach cultivar evaluations are continuing to provide up-to-date information for cultivar selection in the future.

Table 5. Peach cultivars recommended for commercial production in northern Mississippi.

Cultivar	Av. first harvest date	Stone freeness	Chilling requirement*
Harbelle	6/13	SF	850
Pacific Gold	6/14	C	N.A.
Rubired	6/14	C	N.A.
Harken	6/20	F	850
Pekin	6/27	SF	950
Harbrite	6/29	F	850
Sunshine	6/29	F	N.A.
Redhaven	7/2	F	1,050
Norman	7/3	SF	850
Princess Anne	7/3	F	N.A.
Loring	7/6	F	900
Troy	7/6	F	N.A.
Vivid	7/6	F	850
Stark Sunbright	7/9	F	N.A.
Rosy Dawn	7/11	F	N.A.
Sunqueen	7/15	F	N.A.
Redskin	7/28	F	750
Elberta	8/3	F	950
Autumn Gold	8/3	F	N.A.
La Gem	8/13	SF	N.A.

*Number of hours below 45°F needed to break dormancy of flower buds. N.A. = Units not available.

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